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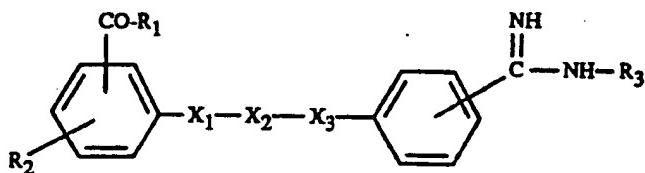
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(54) Title: SUBSTITUTED AMIDINO COMPOUNDS, THEIR MANUFACTURE AND METHODS OF TREATMENT



(57) Abstract

The invention relates to the compounds of formula (I) wherein the C(= NH)-NHR₃ group may be in tautomeric or isomeric form, and pharmaceutically acceptable salts thereof, in which: R₁ is amino which is mono- or disubstituted by a substituent selected from an aliphatic hydrocarbon radical, an araliphatic hydrocarbon radical, an aromatic radical, and a cycloaliphatic hydrocarbon radical or is amino which is disubstituted by a divalent aliphatic hydrocarbon radical or a said radical interrupted by oxygen; R₂ is hydroxy which is etherified by an aliphatic alcohol which is substituted by carboxy, by esterified carboxy or by amidated carboxy; R₃ is hydrogen or an acyl radical which is derived from an organic carbonic acid, an organic carboxylic acid, a sulfonic acid, or a carbamic acid; X₁ and X₃, independently of one another, are oxygen (-O-) or sulphur (-S-); and X₂ is a divalent aliphatic hydrocarbon radical which may be interrupted by an aromatic radical. The compounds are useful as selective LTB₄ receptor antagonists in the treatment of conditions or syndromes in mammals which are responsive to LTB₄ receptor antagonism.

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SUBSTITUTED AMIDINO COMPOUNDS, THEIR MANUFACTURE AND METHODS OF TREATMENT

The invention relates to substituted amidinophenoxyalkoxyphenyl derivatives and thio analogs as defined herein which are particularly useful as selective Leukotriene B₄ (LTB₄) receptor antagonists, methods for preparation thereof, pharmaceutical compositions comprising said compounds, and a method of antagonizing LTB-4 and of treating conditions or syndromes in mammals which are responsive to LTB-4 antagonism using said compounds or pharmaceutical compositions comprising said compounds of the invention.

Leukotriene B₄ (LTB₄) is an important inflammatory mediator being a potent chemotactic agent and activator of polymorphonuclear leucocytes (PMN's) and monocytes. It modulates the production and effects of other important inflammatory mediators e.g. Interleukin-1 and gamma interferon. LTB₄ has been implicated in the pathogenesis of a number of inflammatory diseases, such as rheumatoid arthritis, inflammatory bowel disease, psoriasis, non-steroidal-antiinflammatory-drug-induced gastropathy, adult respiratory distress syndrome (ARDS), myocardial infarction, allergic rhinitis, hemodialysis-induced neutropenia, and late phase asthma.

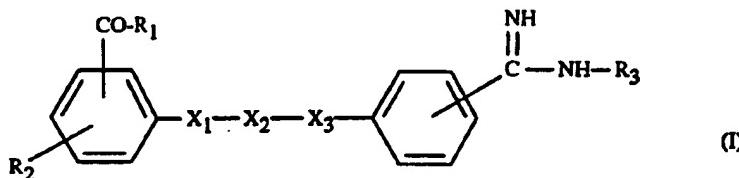
The compounds of the invention are useful for the treatment of the conditions mediated by LTB₄ which are cited above. In addition, the compounds are also useful for the treatment of pain and osteoarthritis, for the treatment of ocular conditions, such as ocular allergy and inflammation, and also for the treatment of dermatitis, such as atopic and contact dermatitis.

There is a strong need in the art in finding potent antagonists of LTB₄ on human PMN's, especially those which are orally active. It has been found that the compounds according to the present invention exhibit significant LTB₄ antagonistic activity on human PMN's

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and are orally active.

The invention relates to substituted amidinophenoxyalkoxyphenyl derivatives and thio analogs of the formula



wherein the C(=NH)-NHR₃ group may be in tautomeric or isomeric form; and pharmaceutically acceptable salts thereof, in which:

R₁ is amino which is mono- or disubstituted by a substituent selected from an aliphatic hydrocarbon radical, an araliphatic hydrocarbon radical, an aromatic radical, and a cycloaliphatic hydrocarbon radical, or is amino which is disubstituted by a divalent aliphatic hydrocarbon radical or a said radical interrupted by oxygen;

R₂ is hydroxy which is etherified by an aliphatic alcohol which is substituted by carboxy, by esterified carboxy or by amidated carboxy;

R₃ is hydrogen or an acyl radical which is derived from an organic carbonic acid, an organic carboxylic acid, a sulfonic acid, or a carbamic acid;

X₁ and X₃, independently of one another, are oxygen (-O-) or sulphur (-S-); and

X₂ is a divalent aliphatic hydrocarbon radical which may be interrupted by an aromatic radical;

wherein the phenyl rings of formula I may be, independently of one another, further substituted by one or more substituents selected from halogen, trifluoromethyl, an aliphatic hydrocarbon radical, hydroxy, and hydroxy which is etherified by an aliphatic alcohol or which is esterified by an aliphatic or araliphatic carboxylic acid;

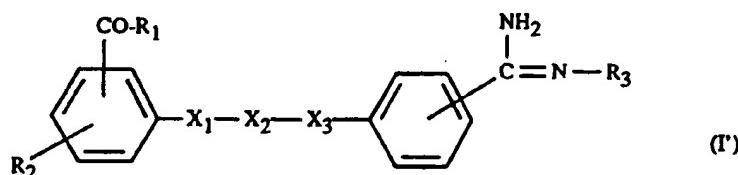
wherein aryl in the above definitions may be, independently of one another, further substituted by one or more substituents selected from halogen, trifluoromethyl, an aliphatic hydrocarbon radical, hydroxy, and hydroxy which is etherified by an aliphatic alcohol or which is esterified by an aliphatic or araliphatic carboxylic acid;

wherein a cycloaliphatic hydrocarbon radical may be substituted by an aliphatic radical; which are particularly useful as selective LTB-4 antagonists, methods for preparation thereof, pharmaceutical compositions comprising said compounds, and a method of

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antagonizing LTB-4 and of treating diseases in mammals which are responsive to LTB-4 antagonism using said compounds or pharmaceutical compositions comprising said compounds of the invention.

The compounds of the invention wherein the C(=NH)-NHR₃ group is in tautomeric or isomeric form are represented by formula I'



wherein R₁, R₂, R₃, X₁, X₂ and X₃ have the meanings as defined for formula I.

As compounds according to the invention have a basic centre, they can thus form acid addition salts, especially pharmaceutically acceptable salts. These are formed, for example, with inorganic acids, such as mineral acids, for example sulfuric acid, a phosphoric or hydrohalic acid, or with organic carboxylic acids, such as (C₁-C₄-)alkanecarboxylic acids which, for example, are unsubstituted or substituted by halogen, for example acetic acid, such as saturated or unsaturated dicarboxylic acids, for example oxalic, malonic, succinic, maleic, fumaric, phthalic or terephthalic acid, such as hydroxycarboxylic acids, for example ascorbic, glycolic, lactic, malic, tartaric or citric acid, such as amino acids, for example aspartic or glutamic acid, benzoic acid or with organic sulfonic acids, such as (C₁-C₄-)alkane- or arylsulfonic acids which are unsubstituted or substituted, for example, by halogen, for example methane- or toluenesulfonic acid. Preferred are salts formed with hydrochloric acid, methanesulfonic acid and maleic acid.

The general definitions used below have, if not defined differently, the following meanings:

An aliphatic hydrocarbon radical is, for example, lower alkyl, lower alkenyl and secondarily lower alkynyl.

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An araliphatic hydrocarbon radical is, for example, optionally substituted phenyl-lower alkyl and secondarily phenyl-lower alkenyl and phenyl-lower alkynyl.

A cycloaliphatic hydrocarbon radical is, for example, cycloalkyl and secondarily cycloalkenyl, which is unsubstituted or mono- or polysubstituted, for example, disubstituted, by lower alkyl.

A divalent aliphatic hydrocarbon radical is, for example, lower alkylene.

A divalent aliphatic radical interrupted by oxygen is, for example, lower alkylene interrupted by oxygen, e.g. ethylene-O-ethylene.

A divalent aliphatic hydrocarbon radical which is interrupted by an aromatic radical is, for example, lower alkylene-phenylene-lower alkylene or lower alkylene-naphthylene-lower alkylene.

An aliphatic alcohol is, for example, a lower alkanol or lower alkenol, and an araliphatic alcohol is, for example, a phenyl-lower alkanol, for example, benzylalcohol.

Hydroxy which is etherified by an aliphatic or araliphatic alcohol is, for example, lower alkoxy or lower alkenyloxy and phenyl-lower alkoxy.

An aliphatic carboxylic acid is, for example, a lower alkanoic or lower alkenoic acid, and an araliphatic carboxylic acid is, for example, a phenyl-lower alkanoic acid.

An acyl radical which is derived from an organic carboxylic acid is, for example, lower alkanoyl, phenyl-lower alkanoyl or unsubstituted or substituted aroyl, such as benzoyl, naphthoyl, indanoyl or fluorenoyl, or heteroaroyl such as pyridylcarbonyl, thienylcarbonyl, pyrrolylcarbonyl, furanylcarbonyl, and imidazolylcarbonyl.

An acyl radical which is derived from an organic carbonic acid is, for example, alkoxy carbonyl or alkenyloxycarbonyl which in each case are unsubstituted or substituted by an aromatic radical or is cycloalkoxycarbonyl which unsubstituted or substituted by lower alkyl.

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An acyl radical which is derived from a sulfonic acid is, for example, alkanesulfonyl, arylalkanesulfonyl, cycloalkanesulfonyl or arylsulfonyl.

An acyl radical which is derived from a carbamic acid is, for example, amino-carbonyl which is substituted by alkyl, arylalkyl or aryl.

An aromatic radical is, for example, unsubstituted or substituted such as monosubstituted or polysubstituted, for example, disubstituted or secondarily trisubstituted carbocyclic aryl, such as phenyl, naphthyl, indanyl or fluorenyl, or heterocyclic aryl, such as pyridyl, thienyl, pyrrolyl, furanyl, and imidazolyl.

Aryl represents preferably monocarbocyclic aryl, advantageously optionally substituted phenyl, such being phenyl or phenyl substituted by e.g. lower alkyl, lower alkoxy, halogen or trifluoromethyl.

The phenyl rings of formulae I and IA as well as aromatic radicals referred to before and hereafter are generally unsubstituted or further substituted such as monosubstituted or polysubstituted, for example disubstituted or secondarily trisubstituted, in particular, for example, by a substituent selected from the group consisting of halogen, trifluoromethyl, lower alkyl, lower alkenyl, lower alkynyl, hydroxy, lower alkoxy, lower alkenyloxy, phenyl-lower alkoxy, lower alkanoyloxy, lower alkenoyloxy, and phenyl-lower alkanoyloxy. Preferably, the phenyl rings of formula I and IA do not exhibit any additional substituent.

Preferred positions of the following structural elements in the corresponding phenyl ring in formula I are: positions 4 (para) or 5 (meta) for -CO-R₁, position 2 (ortho) or 3 (meta) for R₂, and position 4 (para) for -C(=NH)-NHR₃. The substituent R₃ may be located on either nitrogen of the -C(=NH)NH₂ grouping and both tautomeric or isomeric forms are encompassed by the instant invention.

The term "substituted by one or more substituents" refers preferably to one, two or three such substituents, advantageously one or two.

The expression "lower" means that corresponding groups and compounds in each case contain in particular not more than 7, preferably not more than 4, carbon atoms.

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Halogen is, in particular, fluorine, chlorine or bromine, and furthermore includes iodine.

Lower alkyl is, in particular, C₁-C₇-alkyl and is, for example, methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl and furthermore includes corresponding pentyl, hexyl and heptyl radicals. C₁-C₄-Alkyl is preferred.

Lower alkenyl is, in particular, C₃-C₇-alkenyl and is, for example, 2-propenyl or 1-, 2- or 3-butenyl. C₃-C₅-Alkenyl is preferred.

Lower alkynyl is, in particular, C₃-C₇-alkynyl and is preferably propargyl.

Phenyl-lower alkyl is, in particular, phenyl-C₁-C₄-alkyl and is preferably benzyl, 1- and 2-phenethyl, while phenyl-lower alkenyl and phenyl-lower alkynyl are, in particular, phenyl-C₂-C₅alkenyl and -alkynyl, in particular 2-phenyl-vinyl, 3-phenylallyl and 3-phenylpropargyl.

Cycloalkyl is, in particular, C₃-C₇-cycloalkyl and is, for example, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and cycloheptyl. Cyclopentyl and cyclohexyl are preferred.

Cycloalkenyl is, in particular, C₃-C₇-cycloalkenyl and is preferably cyclopent-2- or -3-enyl, or cyclohex-2- and -3-en-yl.

Lower alkylene e.g. in amino which is disubstituted by lower alkylene is, in particular, C₂-C₆-alkylene and is, for example, butylene, pentylene, or 2,6-butylene. Preferred is C₄-C₅-alkylene, especially pentylene.

Lower alkylene X₂ is, in particular, C₂-C₈-alkylene, preferably straight-chain, and is, for example, ethylene, propylene, butylene, pentylene, hexylene, heptylene and also octylene. C₄-C₇-Alkylene is preferred, especially pentylene and also butylene, hexylene or heptylene.

Lower alkylene which is interrupted by a phenyl radical (X₂) is, in particular, lower alkylene-phenylene-lower alkylene or lower alkylene-naphthylene-lower alkylene such as C₂-C₄-alkylene-phenylene-C₂-C₄-alkylene or C₂-C₄-alkylene-naphthylene-C₂-C₄-alkylene, preferably straight-chain, and is, for example, methylene-phenylene-methylene, 1,2-ethylene-phenylene-1,2-ethylene, such as

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1,2-ethylene-1,4-phenylene-1,2-ethylene, 1,3-propylene-phenylene-1,3-propylene, such as 1,3-propylene-1,4-phenylene-1,3-propylene, or butylene-phenylene-butylene radicals, also a corresponding 1,2-ethylene-naphthylene-1,2-ethylene radical.

C_2 - C_4 -alkylene-phenylene- C_2 - C_4 -alkylene or C_2 - C_3 -alkylene-naphthylene- C_2 - C_3 -alkylene is preferred, especially 1,2-ethylene-1,4-phenylene-1,2-ethylene.

Lower alkoxy is, in particular, C_1 - C_7 -alkoxy and is, for example, methoxy, ethoxy, n-propyloxy, isopropyloxy, n-butyloxy, isobutyloxy, sec-butyloxy, tert-butyloxy and furthermore includes corresponding pentyloxy, hexyloxy and heptyloxy radicals. C_1 - C_4 -Alkoxy is preferred.

Lower alkenyloxy is, in particular, C_3 - C_7 -alkenyloxy and is, for example, allyloxy or but-2-en- or but-3-enyloxy. C_3 - C_5 -Alkenyloxy is preferred.

Phenyl-lower alkoxy is, in particular, phenyl- C_1 - C_4 -alkoxy, such as benzyloxy, 1- or 2-phenylethoxy, or 1-, 2- or 3-phenylpropyloxy.

Lower alkanoyloxy is, in particular, C_2 - C_8 -alkanoyloxy, in particular, C_2 - C_5 -alkanoyloxy, such as acetyloxy, propionyloxy or pivaloyloxy.

Lower alkenoyloxy is, in particular, C_3 - C_8 -alkenoyloxy, in particular, C_3 - C_5 -alkenoyloxy, such as propenoyloxy.

Phenyl-lower alkanoyloxy is, in particular, phenyl- C_2 - C_8 -alkanoyloxy, in particular, phenyl- C_2 - C_5 -alkanoyloxy, such as phenylacetyloxy, phenylpropionyloxy or phenylpivaloyloxy.

Alkoxycarbonyl is, in particular, C_2 - C_{12} -alkoxycarbonyl and is, for example, methoxy-, ethoxy-, propyloxy- pivaloyloxy- or octyloxy-carbonyl. C_2 - C_9 -Alkoxycarbonyl is preferred.

Alkenyloxycarbonyl is, in particular, C_3 - C_{12} -alkenyloxycarbonyl, for example, allyloxycarbonyl. Preferred is C_3 - C_5 -alkenyloxycarbonyl.

Cycloalkyloxycarbonyl is, in particular, C_3 - C_7 -cycloalkoxycarbonyl, preferred is cyclopentyloxycarbonyl or cyclohexyloxycarbonyl.

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Alkanesulfonyl is, in particular, C₁-C₇alkanesulfonyl and is, for example, methane-, ethane-, n-propane- or isopropanesulfonyl. C₁-C₄-Alkanesulfonyl is preferred.

Arylalkanesulfonyl is, in particular, phenyl-C₁-C₇alkanesulfonyl, for example, benzyl- or 1- or 2-phenylethan-sulfonyl. Phenyl-C₁-C₄-alkane-sulfonyl is preferred.

Cycloalkanesulfonyl is, in particular, C₃-C₇-cycloalkanesulfonyl, preferred is cyclopentanesulfonyl or cyclohexanesulfonyl.

Naphthyl is 1- or 2-naphthyl.

Indanyl is, for example, 1-, 2-, 3- or 4-indanyl:

Fluorenyl is, for example, 1-, 2-, 3-, 4- or 5-fluorenyl.

Lower alkanoyl is, in particular, C₁-C₇-alkanoyl and is, for example, formyl, acetyl, propionyl, butyryl, isobutyryl or pivavolyl. C₂-C₅-Alkanoyl is preferred.

Phenyl-lower alkanoyl is, in particular, phenyl-C₂-C₇-alkanoyl and is, for example, phenylacetyl or 2- or 3-phenylpropionyl. Phenyl-C₂-C₄-alkanoyl is preferred.

Substituted aroyl represents aroyl, such as benzoyl, which is substituted e.g. by lower alkoxy, lower alkyl, hydroxy, hydroxymethyl or by acyloxymethyl (such as lower alkanoyloxymethyl or benzooyloxymethyl).

Naphthoyl is 1- or 2-naphthoyl.

Indanoyl is, for example, 1-, 2-, 3- or 4-indanoyl.

Fluorenoyl is, for example, 1-, 2-, 3-, 4- or 5-fluorenoyl.

Esterified carboxyl represents preferably lower alkoxycarbonyl or aryl-lower alkoxycarbonyl.

Amidated carboxyl represents preferably aminocarbonyl, mono- or di-lower

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alkylaminocarbonyl, (mono-aryl-mono-lower alkyl)aminocarbonyl, mono- or di-(aryl-lower alkyl)aminocarbonyl or (mono-aryl-lower alkyl-mono-lower alkyl)aminocarbonyl.

The compounds of the invention exhibit valuable pharmacological properties in mammals, and are particularly useful as selective Leukotriene B₄ (LTB₄) receptor antagonists, e.g. for the treatment of a condition or syndrome in a mammal responsive to the selective antagonism of LTB₄ receptors, such as rheumatoid arthritis, inflammatory bowel disease, psoriasis, non-steroidal-antiinflammatory-drug-induced gastropathy, adult respiratory distress syndrome (ARDS), myocardial infarction, allergic rhinitis, hemodialysis-induced neutropenia, and late phase asthma. The compounds of the invention are also useful as analgesics for the treatment of pain of any origin, and for the treatment of osteoarthritis, also for the treatment of ocular conditions, such as ocular allergy and inflammation, and also for the treatment of dermatitis, e.g. atopic and contact dermatitis.

The above-cited properties are demonstrable in in vitro and in vivo tests, using advantageously mammals, e.g. rats. Said compounds can be applied in vitro in the form of solutions, e.g. preferably aqueous solutions, and in vivo either enterally or parenterally, advantageously orally, e.g. as a suspension or in aqueous solution. The dosage in vitro may range between about 0.5 ng/ml and about 100 ng/ml. The dosage in vivo may range, depending on the route of administration, between about 1 and about 1000 mg/kg per day.

Beneficial effects are evaluated in pharmacological tests generally known in the art, e.g. as illustrated herein.

Receptor Binding with [³H]-LTB₄ to Intact Human Neutrophils:

Neutrophils (PMN's) are prepared from uncoagulated human venous blood. Blood is dispersed into 50 ml polypropylene tubes containing 15 ml of HESPA (Dupont, Wilmington, DE), and mixed. Tubes are allowed to stand at room temperature for 40 minutes until most of the red blood cells sediment. The supernatants are removed and centrifuged for 5-10 min at 400 x g. The remaining pellets are diluted in 70 ml of Phosphate Buffered Saline without calcium and magnesium (PBS without metals; GIBCO, Grand Island, NY) and 35 ml of this suspension are placed in each of two polypropylene tubes containing 15 ml of Ficoll-Paque (Sigma, St. Louis, MO). Gradients are then centrifuged for 15 minutes at 420 x g. The mononuclear cell layer is discarded

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and the remaining red blood cell pellet is resuspended in 10 ml of PBS without metals. Twenty ml of filtered deionized water are added to the suspension for approximately 20 sec followed by the same volume of buffer at two times the normal concentration. The cell suspension is mixed and centrifuged for 5 min at 200 x g, followed by one wash with buffer, and final resuspension.

Binding of [³H]LTB₄ to LTB₄ receptors is measured in intact human polymorphonuclear leukocytes, as described by Gorman and Lin (Gorman, R. and Lin, A Methods Enzymol. 141: 372-378, 1987). Intact human neutrophils are suspended in Hank's Balanced Salt Solution (HBSS) at a concentration of 3 x 10⁶ cells/assay tube. An aliquot of the cell suspension (300 µl) is added to triplicate tubes containing 50 µl [³H]LTB₄ (specific activity 32 Ci/mmol, DuPont-NEN, Boston, MA) at a final concentration of 0.5 nM, 100 µl buffer and 50 µl drug or buffer. Nonspecific binding is determined in the presence of 300 nM LTB₄. The reaction is initiated by addition of cell suspension and continued at 0°C for 20 min. Bound radioactivity is isolated by vacuum filtration through Whatman GF/C glass fiber filters using a Brandel cell harvester and unbound radioactivity removed with 2 x 5 ml washes with ice-cold saline. Filters are placed in polyethylene scintillation mini-vials to which is added 3.5 ml of Formula-989 scintillation cocktail (NEN). After equilibration, radioactivity determinations and data calculations are performed using non-linear regression analysis on RS/1.

LTB₄-Induced PMN Aggregation

Human PMNs are prepared as previously described. Neutrophil aggregation is assessed by monitoring the intensity of light passing through a suspension of cells (Craddock et al., J. Clin. Invest. 60: 260-264, 1977) using a Payton dual channel aggregometer (model 300BD). Cuvettes containing 0.25 ml of cell suspension (25 x 10⁶ cells/ml) in PBS without calcium and magnesium are incubated with 5 µg/ml ml of cytochalasin B for 2 minutes at 37°C. 5 µl of 2 µM LTB₄ in PBS (20 nM final concentration) are added and the aggregation response monitored for 3-5 min, the time required for optimal response. Compounds are solubilized in 0.01M DMSO and then diluted in PBS to 0.001 M. 5 µl of compound solution is added along with cytochalasin B and cells as described above. Following the preincubation period 5 µl of 2 µM LTB₄ are added and aggregation is measured. Percent inhibition of aggregation is calculated by comparing peak heights in the presence and absence of compound. Percent inhibition is plotted as a function of the log concentration of compound and the IC₅₀ determined directly from the graph.

LTB₄-Induced Neutropenia in the Rat

Male Sprague Dawley rats (crl: CDBR; Charles River, Wilmington, MA.) (250-300 grams) are fasted overnight prior to the experiment. At least six animals are used per treatment group. Rats are given vehicle or compound either intravenously or orally and at intervals after dosing, neutrophil counts are determined from blood samples obtained just prior to and 20 seconds after intravenous infusion of 200 ng LTB₄. In studies where compound is administered orally, drug is given by gavage. When drug is administered intravenously, rats are first anesthetized with 50 mg/kg i.p. of Sodium Pentobarbital. The jugular vein is exposed and cleaned of the surrounding tissue. At 3, 4 or 18 hours following administration of compound or vehicle by either route, blood samples are taken (0.3 ml of blood in 1.5 ml polypropylene microcentrifuge tube containing 0.01 ml 7.5% EDTA). Blood neutrophil counts are determined using a Technicon H-1 hematology instrument. Antagonism of the LTB₄-induced neutropenia response for the compounds tested is calculated.

Analgesic activity can be demonstrated e.g. in the Randall-Selitto test for analgesia, e.g. as described in Arch. Int. Pharmacodyn. Ther. 111, 409 (1957).

Antiinflammatory activity can be demonstrated by measuring the inhibition of the edema and inhibition of the influx of polymorphonuclear (PMN's) and mononuclear leukocytes (monocytes and macrophages) after oral administration in the rat model in which pleurisy is first induced by injecting carrageenin into the pleural cavity, e.g. according to A.P. Almeida et al., J. Pharmacol. Exp. Therap. 214, 74 (1980), in particular during the late phase of the carrageenin-induced pleurisy.

Bronchial effects such as anti-asthmatic activity, can be demonstrated in the antigen-induced guinea pig bronchoconstriction test, e.g. as described by Anderson et al., Br. J. Pharmacol. 1983, 78, 67-74.

The trinitrobenzenesulfonic acid-induced chronic colitis test in the rat, e.g. as described by Wallace et al, Gastroenterology 1989, 96, 29-36, can be used to evaluate compounds for effects indicative of utility in inflammatory bowel diseases.

The arachidonic acid-induced mouse ear edema test, e.g. as described by Young et al, J.

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Invest, Dermatol. 1984, 82, 367-371 can be used to evaluate compounds for effects indicative of utility in dermatological disorders such as psoriasis.

The invention especially relates to compounds of formula I and pharmaceutically acceptable salts thereof, in which:

R₁ is amino which is mono- or disubstituted by a substituent selected from lower alkyl, lower alkenyl, lower alkynyl, phenyl-lower alkyl, phenyl-lower alkenyl, phenyl-lower alkynyl, phenyl, naphthyl, indanyl, fluorenlyl, cycloalkyl, and cycloalkenyl, cycloalkyl and cycloalkenyl each being unsubstituted or mono- or polysubstituted by lower alkyl, or is amino which is disubstituted by lower alkylene;

R₂ is lower alkoxy substituted by carboxy, lower alkoxy carbonyl, aminocarbonyl or mono- or di-lower alkylaminocarbonyl;

R₃ is hydrogen, alkoxy carbonyl or alkenyloxycarbonyl, each of which is unsubstituted or substituted by phenyl, naphthyl, indanyl or fluorenlyl, or is cycloalkoxycarbonyl being unsubstituted or mono- or polysubstituted by lower alkyl, or is lower alkanoyl or phenyl-lower alkanoyl, or is benzoyl, naphthoyl, indanoyl or fluorenoyl, or is C₁-C₇alkanesulfonyl, phenyl-C₁-C₇alkanesulfonyl, C₃-C₇-cycloalkanesulfonyl, or phenylsulfonyl, or is aminocarbonyl which is substituted by lower alkyl, phenyl-lower alkyl or phenyl;

X₁ and X₃, independently of one another, are O or S;

X₂ is lower alkylene, lower alkylene-phenylene-lower alkylene or lower alkylene-naphthylene-lower alkylene;

wherein the phenyl rings of formula I may be, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, lower alkyl, lower alkenyl, lower alkynyl, hydroxy, lower alkoxy, lower alkenyloxy, phenyl-lower alkoxy, lower alkanoyloxy, lower alkenoyloxy and phenyl-lower alkanoyloxy;

wherein the aromatic radicals in the above definitions may be, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, lower alkyl, lower alkenyl, lower alkynyl, hydroxy, lower alkoxy, lower alkenyloxy, phenyl-lower alkoxy, lower alkanoyloxy, lower alkenoyloxy and phenyl-lower alkanoyloxy.

The invention especially relates to compounds of formula I and pharmaceutically acceptable salts thereof, in which:

R₁ is amino which is mono- or disubstituted by a substituent selected from C₁-C₇-alkyl, phenyl-C₁-C₇-alkyl, phenyl and C₃-C₆-cycloalkyl, C₃-C₆-cycloalkyl being unsubstituted

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or mono- or polysubstituted by C₁-C₇-alkyl, or is amino which is disubstituted by C₃-C₆-alkylene;

R₂ is C₁-C₇-alkoxy substituted by carboxy or lower alkoxy carbonyl;

R₃ is hydrogen, C₁-C₁₂-alkoxy-carbonyl, C₂-C₅-alkanoyl, phenyl-C₂-C₅-alkanoyl, benzoyl which is unsubstituted or substituted by halogen, trifluoromethyl, C₁-C₇-alkyl, or C₁-C₇-alkoxy, C₃-C₆-cycloalkyl carbonyl which is unsubstituted or substituted by C₁-C₇-alkyl, or is benzoyl, naphthoyl, indanoyl or fluorenoyl, or is C₁-C₇-alkanesulfonyl, phenyl-C₁-C₇-alkanesulfonyl, C₃-C₇-cycloalkanesulfonyl, or phenylsulfonyl, or is aminocarbonyl which is substituted by C₁-C₇-alkyl, phenyl-C₁-C₇-alkyl or phenyl;

X₁ and X₃ each are -O-, or furthermore are, independently of one another, -O- or -S-;

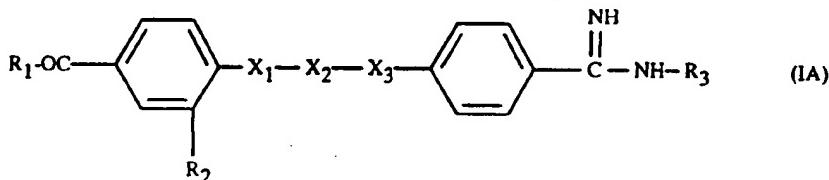
X₂ is C₂-C₇-alkylene or C₂-C₄-alkylene-phenylene-C₂-C₄-alkylene;

wherein the phenyl rings of formula I may be unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C₁-C₇-alkyl, and C₁-C₇-alkoxy;

wherein phenyl in the above definitions is unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C₁-C₇-alkyl, and C₁-C₇-alkoxy.

The invention especially relates to compounds of formula I and pharmaceutically acceptable salts thereof, in which -CO-R₁ is located in position 4 (para) or 3 or 5 (meta) of the corresponding phenyl ring with respect to -X₁-; R₂- is located in position 2 (ortho) or 3 (meta) of the corresponding phenyl ring with respect to -X₁-; and -C(=NH)-NHR₃ is located in position 4 (para) of the corresponding phenyl ring with respect to -X₃-.

The invention especially relates to compounds of formula IA



wherein the C(=NH)-NHR₃ group may be in tautomeric or isomeric form, and pharmaceutically acceptable salts thereof, in which:

R₁ is di-C₁-C₄-alkylamino, such as di-ethylamino or di-isopropylamino,

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C_1 - C_4 alkyl-(phenyl)amino, such as phenyl-isopropyl-amino,
 C_1 - C_4 alkyl-(phenyl- C_1 - C_4 -alkyl)-amino, such as methyl-benzyl-amino,
di- C_3 - C_6 -cycloalkylamino, such as di-cyclohexylamino, which is unsubstituted or substituted by C_1 - C_4 -alkyl, or 1-piperidino substituted by C_1 - C_4 -alkyl, such as 2-methyl-1-piperidino;
 R_2 is C_1 - C_4 -alkoxy which is substituted by carboxy, lower alkoxy carbonyl, aminocarbonyl or by mono- or di-lower alkylaminocarbonyl;
 R_3 is hydrogen, C_1 - C_{12} -alkoxycarbonyl, such as methoxycarbonyl or octyloxycarbonyl, phenyl- C_1 - C_4 -alkoxycarbonyl, such as benzyloxycarbonyl, C_2 - C_5 -alkanoyl, such as acetyl, benzoyl which is unsubstituted or substituted by halogen, trifluoromethyl, C_1 - C_4 -alkyl or by C_1 - C_4 -alkoxy, such as 3,4-dimethoxybenzoyl, C_3 - C_6 -cycloalkylcarbonyl which is unsubstituted or substituted by C_1 - C_4 -alkyl, such as 2-isopropyl-5-methyl-cyclohexylcarbonyl;
 X_1 and X_3 are -O-;
 X_2 is C_4 - C_7 -alkylene, such as pentylene;
wherein the phenyl rings of formula IA may be unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C_1 - C_4 -alkyl, and C_1 - C_4 -alkoxy.

The invention especially relates to compounds of formula IA and pharmaceutically acceptable salts thereof, in which:

R_1 is di- C_1 - C_4 -alkylamino, such as di-ethylamino or di-isopropylamino,
 C_1 - C_4 -alkyl-(phenyl)-amino, such as phenyl-isopropyl-amino,
 C_1 - C_4 -alkyl-(phenyl- C_1 - C_4 -alkyl)-amino, such as methyl-benzyl-amino,
di- C_3 - C_6 -cycloalkylamino, such as di-cyclohexylamino which is unsubstituted or substituted by C_1 - C_4 -alkyl, or 1-piperidino substituted by C_1 - C_4 -alkyl, such as 2-methyl-1-piperidino;
 R_2 is C_1 - C_4 -alkoxy which is substituted by carboxy, lower alkoxy carbonyl, aminocarbonyl or mono- or di-lower alkylaminocarbonyl;
 R_3 is C_1 - C_4 alkanesulfonyl, such as methane-, ethane- or isopropanesulfonyl, phenyl- C_1 - C_4 -alkanesulfonyl, such as benzylsulfonyl, C_3 - C_7 -cycloalkane-sulfonyl, such as cyclohexanesulfonyl, or phenylsulfonyl, or aminocarbonyl which is substituted by C_1 - C_4 -alkyl, phenyl- C_1 - C_4 -alkyl or phenyl;
 X_1 and X_3 are -O-;
 X_2 is C_4 - C_7 -alkylene, such as pentylene.

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The invention especially relates to compounds of formula IA and pharmaceutically acceptable salts thereof, in which:

R₁ is di-C₁-C₄-alkylamino, such as di-ethylamino or di-isopropylamino,
C₁-C₄-alkyl-(phenyl)-amino, such as phenyl-isopropyl-amino,
C₁-C₄-alkyl-(phenyl-C₁-C₄-alkyl)-amino, such as methyl-benzyl-amino,
di-C₃-C₆-cycloalkylamino, such as di-cyclohexylamino which is unsubstituted or substituted by C₁-C₄-alkyl, or 1-piperidino substituted by C₁-C₄-alkyl, such as 2-methyl-1-piperidino;
R₂ is C₁-C₄-alkoxy substituted by C₁-C₄-alkoxycarbonyl, such as ethoxycarbonylmethyl, or by aminocarbonyl;
R₃ is hydrogen; or R₃ is lower alkanoyl, such as acetyl;
X₁ and X₃ are -O-;
X₂ is C₄-C₇-alkylene, such as pentylene.

The invention further especially relates to compounds of formula IA and pharmaceutically acceptable salts thereof, in which:

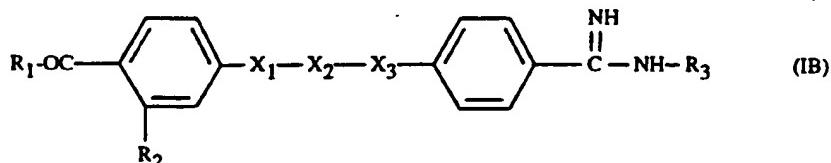
R₁ is di-C₁-C₄-alkylamino, such as di-isopropylamino;
R₂ is C₁-C₄-alkoxy substituted by C₁-C₄-alkoxycarbonyl, such as ethoxycarbonyl or by aminocarbonyl
R₃ is C₁-C₁₂-alkoxycarbonyl, such as methoxycarbonyl or octyloxycarbonyl, phenyl-C₁-C₄-alkoxycarbonyl, such as benzyloxycarbonyl, C₂-C₅-alkanoyl, such as acetyl, benzoyl which is unsubstituted or substituted by halogen, trifluoromethyl, C₁-C₄-alkyl, or C₁-C₄-alkoxy, such as 3,4-dimethoxybenzoyl, C₃-C₆-cycloalkylcarbonyl which is unsubstituted or substituted by C₁-C₄-alkyl, such as 2-isopropyl-5-methyl-cyclohexylcarbonyl;
X₁ and X₃ are -O-;
X₂ is C₄-C₇-alkylene, especially pentylene.

The invention further especially relates to compounds of formula IA and pharmaceutically acceptable salts thereof, in which:

R₁ is di-C₁-C₄-alkylamino, such as di-ethylamino or di-isopropylamino;
R₂ is C₁-C₄-alkoxy substituted by C₁-C₄-alkoxycarbonyl such as ethoxycarbonyl or by aminocarbonyl,
R₃ is hydrogen or C₁-C₄-alkanoyl, such as acetyl;
X₁ and X₃ are -O-;
X₂ is C₄-C₇-alkylene, especially pentylene.

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The invention also particularly relates to the compounds of formula IB



wherein the C(=NH)-NHR₃ group may be in tautomeric or isomeric form, and pharmaceutically acceptable salts thereof, in which:

R₁ is di-C₁-C₄-alkylamino, such as di-ethylamino or di-isopropylamino,
 C₁-C₄alkyl-(phenyl)amino, such as phenyl-isopropyl-amino,
 C₁-C₄-alkyl-(phenyl-C₁-C₄-alkyl)-amino, such as methyl-benzyl-amino,
 di-C₃-C₆-cycloalkylamino, such as di-cyclohexylamino, which is unsubstituted or substituted by C₁-C₄-alkyl, or 1-piperidino substituted by C₁-C₄-alkyl, such as 2-methyl-1-piperidino;
 R₂ is C₁-C₄-alkoxy which is substituted by carboxy, lower alkoxy carbonyl, aminocarbonyl or by mono- or di-lower alkylaminocarbonyl;
 R₃ is hydrogen, C₁-C₁₂-alkoxycarbonyl, such as methoxycarbonyl or octyloxycarbonyl, phenyl-C₁-C₄-alkoxycarbonyl, such as benzyloxycarbonyl, C₂-C₅-alkanoyl, such as acetyl, benzoyl which is unsubstituted or substituted by halogen, trifluoromethyl, C₁-C₄-alkyl, or C₁-C₄-alkoxy, such as 3,4-dimethoxybenzoyl, C₃-C₆-cycloalkylcarbonyl which is unsubstituted or substituted by C₁-C₄-alkyl, such as 2-isopropyl-5-methyl-cyclohexylcarbonyl;
 X₁ and X₃ are -O-;
 X₂ is C₄-C₇-alkylene, such as pentylene;
 wherein the phenyl rings of formula IB may be unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C₁-C₄-alkyl, and C₁-C₄-alkoxy.

The invention especially relates to compounds of formula IB and pharmaceutically acceptable salts thereof, in which:

R₁ is di-C₁-C₄-alkylamino, such as di-ethylamino or di-isopropylamino,
 C₁-C₄-alkyl-(phenyl)-amino, such as phenyl-isopropyl-amino,

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$C_1\text{-}C_4\text{alkyl-(phenyl-}C_1\text{-}C_4\text{-alkyl)-amino}$, such as methyl-benzyl-amino,
 $\text{di-}C_3\text{-}C_6\text{-cycloalkylamino}$, such as di-cyclohexylamino, which is unsubstituted or
substituted by $C_1\text{-}C_4\text{-alkyl}$, or 1-piperidino substituted by $C_1\text{-}C_4\text{-alkyl}$, such as
2-methyl-1-piperidino;
 R_2 is $C_1\text{-}C_4\text{-alkoxy}$ which is substituted by carboxy, lower alkoxycarbonyl, aminocarbonyl
or mono- or di-lower alkylaminocarbonyl;
 R_3 is $C_1\text{-}C_4\text{alkanesulfonyl}$, such as methane-, ethane- or isopropanesulfonyl,
 $\text{phenyl-}C_1\text{-}C_4\text{alkanesulfonyl}$, such as benzylsulfonyl, $C_3\text{-}C_7\text{-cycloalkane-sulfonyl}$, such as
cyclohexanesulfonyl, or phenylsulfonyl, or aminocarbonyl which is substituted by
 $C_1\text{-}C_4\text{-alkyl}$, phenyl- $C_1\text{-}C_4\text{-alkyl}$ or phenyl;
 X_1 and X_3 are -O-;
 X_2 is $C_4\text{-}C_7\text{-alkylene}$, such as pentylene.

The invention especially relates to compounds of formula IB and pharmaceutically acceptable salts thereof, in which:

R_1 is $\text{di-}C_1\text{-}C_4\text{-alkylamino}$, such as di-ethylamino or di-isopropylamino,
 $C_1\text{-}C_4\text{-alkyl-(phenyl)-amino}$, such as phenyl-isopropyl-amino,
 $C_1\text{-}C_4\text{alkyl-(phenyl-}C_1\text{-}C_4\text{-alkyl)-amino}$, such as methyl-benzyl-amino,
 $\text{di-}C_3\text{-}C_6\text{-cycloalkylamino}$, such as di-cyclohexylamino, which is unsubstituted or
substituted by $C_1\text{-}C_4\text{-alkyl}$, or 1-piperidino substituted by $C_1\text{-}C_4\text{-alkyl}$, such as
2-methyl-1-piperidino;
 R_2 is $C_1\text{-}C_4\text{-alkoxy}$ substituted by $C_1\text{-}C_4\text{-alkoxycarbonyl}$, such as ethoxycarbonylmethoxy
or by aminocarbonyl, such as carbamoylmethoxy;
 R_3 is hydrogen; or R_3 is $C_2\text{-}C_5\text{-alkanoyl}$, such as acetyl;
 X_1 and X_3 are -O-;
 X_2 is $C_4\text{-}C_7\text{-alkylene}$, such as pentylene.

The invention further especially relates to compounds of formula IB and pharmaceutically acceptable salts thereof, in which:

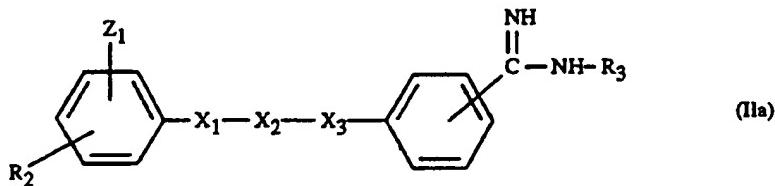
R_1 is $\text{di-}C_1\text{-}C_4\text{-alkylamino}$, such as di-ethylamino or di-isopropylamino;
 R_2 is $C_1\text{-}C_4\text{-alkoxycarbonylmethoxy}$, such as ethoxycarbonylmethoxy or
aminocarbonylmethoxy;
 R_3 is hydrogen or $C_2\text{-}C_5\text{-alkanoyl}$, such as acetyl;
 X_1 and X_3 are -O-;
 X_2 is $C_4\text{-}C_7\text{-alkylene}$, especially pentylene.

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The invention relates in particular to the novel compounds itemized in the examples and to the manners of preparation described therein.

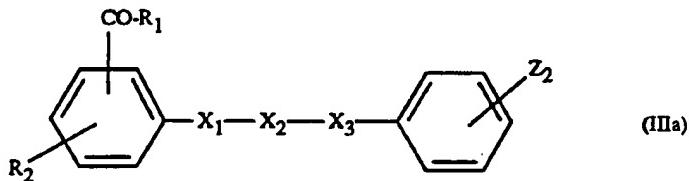
The invention further relates to methods for the preparation of the compounds according to the invention. The preparation of compounds of the formula I is, for example, characterized in that,

- a) a compound of the formula IIa



or a salt thereof in which Z₁ is a radical which can be converted into the variable -CO-R₁, Z₁ is converted into the variable -CO-R₁, or,

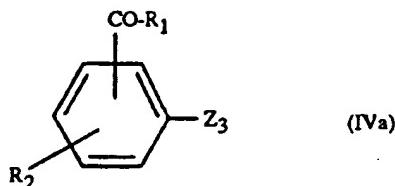
- b) for the manufacture of compounds of the formula I in which R₃ is hydrogen, in a compound of the formula IIIa



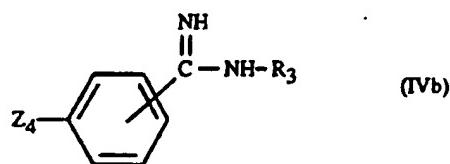
or a salt thereof in which Z₂ is a radical which can be converted into the variable -C(=NH)-NH-R₃, Z₂ is converted into the variable -C(=NH)-NH-R₃, or

- c) a compound of the formula IVa

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or a salt thereof is reacted with a compound of the formula IVb



or a salt thereof in which Z_3 is a group of the formula $-X_1-X_2-Z_5$ and Z_4 is $-Z_6$, or Z_3 is $-Z_6$ and Z_4 is a group of the formula $Z_5-X_2-X_3-$, wherein one of the radicals Z_5 and Z_6 is hydroxy or mercapto and the other is hydroxy, mercapto or reactive esterified hydroxy,

and, if desired, a compound of the formula I or a salt thereof obtainable according to the process or in another manner is converted into another compound or a salt thereof according to the invention, a free compound of the formula I obtainable according to the process is converted into a salt, a salt obtainable according to the process is converted into the free compound of the formula I or into another salt, or a mixture of isomers obtainable according to the process is resolved and the desired compound is isolated.

Salts of starting materials which contain at least one basic centre, for example of the formula IIa, are appropriate acid addition salts, while salts of starting materials which contain an acid group are present as salts with bases.

A radical Z_1 which can be converted into the variable $-CO-R_1$ is, for example, cyano, carboxy or a salt or activated carboxy.

A radical Z_2 which can be converted into the variable $-C(=NH)-NHR_3$ is, for example, (lower) alkoxy-iminocarbonyl or halogeno-iminocarbonyl [Halogeno- $C(=NH)-$].

Reactive esterified hydroxy (e.g. Z_5 or Z_6) is, in particular, hydroxy esterified with a strong inorganic acid or organic sulfonic acid, and is, for example, halogen, such as

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chlorine, bromine or iodine, sulfonyloxy, such as hydroxysulfonyloxy, halosulfonyloxy, such as, fluorosulfonyloxy, (C_1 - C_7 -)alkanesulfonyloxy which, if desired, is substituted, for example, by halogen, such as, methane- or trifluoromethanesulfonyloxy, (C_5 - C_7 -)cycloalkanesulfonyloxy, such as, cyclohexanesulfonyloxy, or benzenesulfonyloxy which, if desired, is substituted, for example by (C_1 - C_7 -)alkyl or halogen, such as, p-bromobenzene- or p-toluenesulfonyloxy.

The reactions described in the variants above and below are carried out in a manner known per se, for example in the absence or in the customary manner in the presence of a suitable solvent or diluent or a mixture thereof, the reaction being carried out, according to need, with cooling, at room temperature or with warming, for example in a temperature range from about -80°C up to the boiling point of the reaction medium, preferably from about -10°C to about +180°C, and, if necessary, in a closed vessel, under pressure, in an inert gas atmosphere and/or under anhydrous conditions.

Process a):

A compound of the formula IIa in which Z_1 is activated carboxy (Z_1) is, for example, an anhydride thereof, including a mixed anhydride, such as an acid halide, for example chloride, or an anhydride with a formic ester, an activated carboxylic ester such as cyanomethyl, (4-)nitrophenyl, polyhalogenophenyl, for example pentachlorophenyl, esters.

The reaction is, for example, carried out with an agent suitable to introduce R_3 , for example, an amine of the formula H- R_1 . The reaction with compounds of the formula IIa in which Z_1 carboxy or a salt thereof, for example, takes place under water-eliminating conditions, for example, with azeotropic removal of the water of reaction, or by treatment with a suitable condensing agent, for example, N,N'-dicyclohexyl-carbodiimide. The reaction with an activated carboxy derivative may advantageously be carried out in the presence of a base.

Suitable bases are, for example, alkali metal hydroxides, hydrides, amides, alkanolates, carbonates, triphenylmethylides, di(lower alkyl)amides, aminoalkylamides or lower alkyl silylamides, or naphthaleneamines, lower alkylamines, basic heterocycles, ammonium hydroxides, and also carbocyclic amines. Examples which may be mentioned are sodium hydroxide, sodium hydride, sodium amide, sodium (m)ethoxide, potassium tert-butoxide,

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potassium carbonate, lithium triphenylmethylide, lithium diisopropylamide, potassium 3-(aminopropyl)amide, potassium bis(trimethylsilyl)amide, dimethylaminonaphthalene, di- or triethylamine, or ethyldiisopropylamine, N-methylpiperidine, pyridine, benzyltrimethylammonium hydroxide, 1,5-diazabicyclo[4.3.0]non-5-ene (DBN) and 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU).

Preferably, those compounds of the formula IIa are employed in which Z_1 is activated carboxy. The corresponding reaction is carried out using an amine of the formula H-R₁. Preferred compounds of the formula IIa are corresponding acid halides such as acid chlorides or bromides derivatives thereof.

Process b):

Alkoxy-iminocarbonyl is, for example C₁-C₄alkoxy-iminocarbonyl such as methoxy- or ethoxy-iminocarbonyl, whereas halogeno-iminocarbonyl is, for example chloro-iminocarbonyl.

Preferably, those compounds of the formula IIIa are employed in which Z_2 is C₁-C₄alkoxy-iminocarbonyl such as methoxy- or ethoxy-iminocarbonyl. The reaction is preferably carried out by reacting with ammonia and using an acid resulting in the corresponding acid addition salt of the product. As acids are used, for example, inorganic acids, such as mineral acids, for example sulfuric acid, a phosphoric or hydrohalic acid, or with organic carboxylic acids, such as (C₁-C₄)alkanecarboxylic acids which, for example, are unsubstituted or substituted by halogen, for example acetic acid, such as saturated or unsaturated dicarboxylic acids, for example oxalic, malonic, succinic, maleic, fumaric, phthalic or terephthalic acid, such as hydroxycarboxylic acids, for example ascorbic, glycolic, lactic, malic, tartaric or citric acid, such as amino acids, for example aspartic or glutamic acid, benzoic acid or with organic sulfonic acids, such as (C₁-C₄)alkane- or arylsulfonic acids which are unsubstituted or substituted, for example, by halogen, for example methane- or toluenesulfonic acid. Preferred acids are hydrohalic acids, especially hydrochloric acid, organic sulfonic acids, especially methanesulfonic acid, or dicarboxylic acids, especially maleic acid.

Process c):

Preferably, those compounds of the formulae IVa and IVb are employed in which Z_3 is a

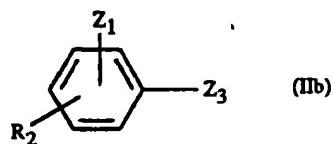
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group of the formula $-X_1-X_2-Z_5$, wherein Z_5 is halogen, especially bromine, and Z_4 is hydroxy.

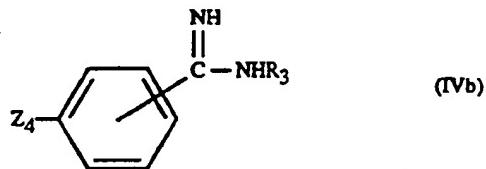
The reaction is carried out preferably in the presence of a base e.g. as mentioned above, such as cesium carbonate.

The starting material can be prepared following methods known per se.

In order to prepare the starting material of the formula IIa, for example, a compound of the formula (IIb)

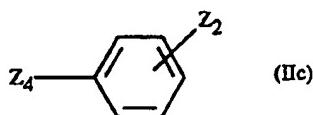


in which Z_3 preferably is a group of the formula $-X_1-X_2-Z_5$, wherein Z_5 preferably is reactive esterified hydroxy, is reacted with a compound of the formula



in which Z_4 is hydroxy or mercapto, following the method as described in process c).

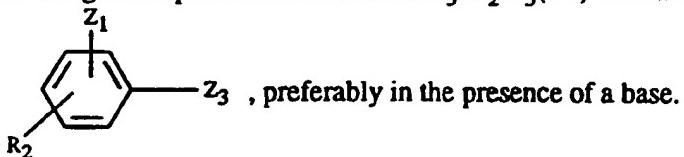
If one of variables Z_3 and Z_5 represents reactive esterified hydroxy, the other preferably represents hydroxy or mercapto. A compound of the formula IVb can be obtained, for example, by converting Z_2 of a compound of the formula



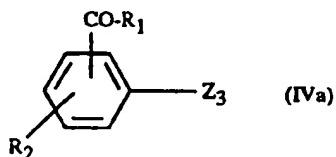
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in which Z_2 is a radical which can be converted into the variable $-C(=NH)-NH-R_3$, following the method as described in process b). Compounds of formulae (IIb) and (IIc) are known or can be prepared according to methods known per se.

Preferably, Z_3 is a group of the formula $X_1-X_2-Z_5$, wherein Z_5 preferably is reactive esterified hydroxy, such as chlorine or bromine, and Z_4 is hydroxy or furthermore mercapto. A corresponding compound of the formula IIb can be obtained, for example, by reacting a compound of the formula $Z_5-X_2-Z_5$ (IId) with a compound of the formula



In order to prepare the starting material of the formula IIIa, Z_1 of a compound of the formula (IIb) is converted into radical $-CO-R_1$ following the method as described in process a) resulting in compound of the formula



which, in the next step, is reacted with a compound of the formula (IIc) following the method as described in process c).

Relating to compounds wherein R_2 represents lower alkoxy substituted by carboxy, by esterified carboxy or by amidated carboxy, such compounds can be prepared from intermediates obtained by alkylation of starting materials or intermediates wherein R_2 is hydroxy with the appropriate reactive esterified hydroxy-substituted carboxylic acids or amides, e.g. the bromo-substituted lower alkyl carboxylic acid esters or amides. The esters can in turn be converted to the carboxylic acids or amides by methods well-known in the art. The starting materials and intermediates wherein R_2 is hydroxy are prepared from compounds wherein R_2 is e.g. methoxy by solvolysis thereof, e.g. with boron tribromide.

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The invention further includes any variant of the present processes, in which an intermediate product obtainable at any stage thereof is used as starting material and the remaining steps are carried out, or the process is discontinued at any stage thereof, or in which the starting materials are formed under the reaction conditions, or in which the reaction components are used in the form of their salts or optically pure antipodes.

A compound according to the invention which is obtainable by the process can be converted into another compound according to the invention in a manner known per se.

If one of the variables contains mono-substituted amino (for example R_1), corresponding compounds of the formula I or salts thereof can be N-alkylated in a manner known per se; likewise, N-mono-substituted carbamoyl (for example R_1), can further be N-alkylated. The (aryl-)alkylation is carried out, for example, using a reactive ester of an (aryl-)C₁-C₇-alkyl halide, for example a bromide or iodide, an (aryl-)C₁-C₇-alkylsulfonate, for example a methanesulfonate or p-toluenesulfonate, or a di-C₁-C₇-alkyl sulfate, for example dimethyl sulfate, preferably under basic conditions, such as in the presence of sodium hydroxide solution or potassium hydroxide solution, and advantageously in the presence of a phase-transfer catalyst, such as tetrabutylammonium bromide or benzyltrimethylammonium chloride, where, however, stronger basic condensing agents, such as alkali metal amides, hydrides or alkoxides, for example sodium amide, sodium hydride or sodium ethoxide, may be necessary.

If R_3 is hydrogen, the corresponding amidino group can be N-acylated accordingly. The acylation is carried out in a manner known per se using a suitable acylating agent. An example of a suitable acylating agent is a compound of the formula Ac-Z₇, where Ac denotes an acyl radical corresponding to the variable R_3 , and Z₇ denotes in particular reactive activated hydroxyl. Appropriate hydroxyl can be activated, for example, by strong acids such as hydrohalic or carboxylic acid, for example by hydrochloric, hydrobromic acid, an optionally substituted, for example by halogen, alkanecarboxylic acid or by an acid of the formula Ac-OH, or by suitable activating or coupling reagents of the type detailed hereinafter, in particular in situ. Ac-Z₇ can furthermore represent an activated ester, where Z₇ denotes, in particular, cyanomethoxy, phenoxy, (4-)nitrophenoxy or polyhalogeno-, such as pentachlorophenoxy. Activating and coupling reagents which can be employed are, in particular, carbodiimides, for example N,N'-di-C₁-C₄-alkyl- or N,N'-di-C₅-C₇-cycloalkyl-carbodiimide, such as diisopropylcarbodiimide or N,N'-dicyclohexylcarbodiimide, advantageously with the addition of an activating catalyst

such as N-hydroxysuccinimide or optionally substituted, for example by halogen, C₁-C₇-alkyl or C₁-C₇-alkoxy, N-hydroxy-benzotriazole or N-hydroxy-5-norbornene-2,3-dicarboxamide, furthermore C₁-C₄-alkyl halogenoformate, for example isobutyl chloroformate, suitable carbonyl compounds, for example N,N-carbonyldiimidazole, suitable 1,2-oxazolium compounds, for example 2-ethyl-5-phenyl-1,2-oxazolium 3'-sulfonate or 2-tert-butyl-5-methyl-1-oxazolium perchlorate, suitable acylamino compounds, for example 2-ethoxy-1-ethoxycarbonyl-1,2-dihydroquinoline, or suitable phosphoryl cyanamides or azides, for example diethylphosphoryl cyanamide or diphenylphosphoryl azide, furthermore triphenylphosphine disulfide or 1-C₁-C₄-alkyl-2-halogeno-pyridinium halides, for example 1-methyl-2-chloropyridinium iodide. Z₇ preferably denotes halogen such as chlorine or bromine, Ac-O-, and advantageously phenoxy.

If the compounds of the formula (I), (IA) or (IB) contain unsaturated radicals, such as (lower)alkenyl groups, these can be converted into saturated radicals in a manner known per se. Thus, for example, multiple bonds are hydrogenated by catalytic hydrogenation in the presence of hydrogenation catalysts, suitable for this purpose being, for example, nickel, such as Raney nickel, and noble metals or their derivatives, for example oxides, such as palladium or platinum oxide, which may be applied, if desired, to support materials, for example to carbon or calcium carbonate. The hydrogenation may preferably carried out at pressures between 1 and about 100 atm and at room temperature between about -80° to about 200°C, in particular between room temperature and about 100°C. The reaction is advantageously carried out in a solvent, such as water, a lower alkanol, for example ethanol, isopropanol or n-butanol, an ether, for example dioxane, or a lower alkanecarboxylic acid, for example acetic acid.

The invention also relates to any novel starting materials and processes for their manufacture and their use.

Depending on the choice of starting materials and methods, the new compounds may be in the form of one of the possible isomers or mixtures thereof, for example, as substantially pure geometric (cis or trans) isomers, optical isomers (antipodes), racemates, or mixtures thereof. The aforesaid possible isomers or mixtures thereof are within the purview of this invention.

Any resulting mixtures of isomers can be separated on the basis of the physico-chemical differences of the constituents, into the pure geometric or optical isomers, diastereoisomers, racemates, for example by chromatography and/or fractional crystallization.

Any resulting racemates of final products or intermediates can be resolved into the optical antipodes by known methods, e.g. by separation of the diastereoisomeric salts thereof, obtained with an optically active acid or base, and liberating the optically active acidic or basic compound. Racemic amidines (wherein R₃ represents hydrogen) can thus be resolved into their optical antipodes e.g. by fractional crystallization of a salt formed with an optically active acid.

Finally, the compounds of the invention are either obtained in the free form, or as a salt thereof.

In view of the close relationship between the free compounds and the compounds in the form of their salts, whenever a compound is referred to in this context, a corresponding salt is also intended, provided such is possible or appropriate under the circumstances.

The compounds, including their salts, can also be obtained in the form of their hydrates, or include other solvents used for their crystallization.

The pharmaceutical compositions according to the invention are those suitable for enteral, such as oral or rectal, transdermal and parenteral administration to mammals, including man, to antagonize LTB₄ receptors, and for the treatment of a condition or syndrome responsive to the selective antagonism of LTB₄ receptors, comprising an effective amount of a pharmacologically active compound of the invention, alone or in combination, with one or more pharmaceutically acceptable carriers.

The novel pharmaceutical products contain, for example, from about 10 % to about 80 %, preferably from about 20 % to about 60 %, of the active compound. Examples of pharmaceutical products according to the invention for enteral or parenteral administration are those in dose-unit forms such as coated tablets, tablets, capsules or suppositories, as well as ampoules. These are prepared in a manner known per se, for example using conventional mixing, granulating, coating, dissolving or freeze-drying processes. Thus, pharmaceutical products for oral use can be obtained by combining the active compound

with solid excipients, where appropriate granulating a mixture which is obtained, and processing the mixture or granules, if desired or necessary, after addition of suitable auxiliaries to tablets or cores of coated tablets.

The pharmacologically active compounds of the invention are useful in the manufacture of pharmaceutical compositions comprising an effective amount thereof in conjunction or admixture with excipients or carriers suitable for either enteral or parenteral application. Preferred are tablets and gelatin capsules comprising the active ingredient together with a) diluents, e.g. lactose, dextrose, sucrose, mannitol, sorbitol, cellulose and/or glycine; b) lubricants, e.g. silica, talcum, stearic acid, its magnesium or calcium salt and/or polyethyleneglycol; for tablets also c) binders e.g. magnesium aluminum silicate, starch paste, gelatin, tragacanth, methylcellulose, sodium carboxymethylcellulose and/or polyvinylpyrrolidone; if desired d) disintegrants, e.g. starches, agar, alginic acid or its sodium salt, or effervescent mixtures; and/or e) absorbants, colorants, flavors and sweeteners. Injectable compositions are preferably aqueous isotonic solutions or suspensions, and suppositories are advantageously prepared from fatty emulsions or suspensions. Said compositions may be sterilized and/or contain adjuvants, such as preserving, stabilizing, wetting or emulsifying agents, solution promoters, salts for regulating the osmotic pressure and/or buffers. Cores of coated tablets are provided with suitable, optionally enteric, coatings, using, inter alia, concentrated sugar solutions which optionally contain gum arabic, talc, polyvinylpyrrolidone, polyethylene glycol and/or titanium dioxide, lacquer solutions in suitable organic solvents or solvent mixtures or, for the preparation of enteric coatings, solutions of suitable cellulose products such as acetyl cellulose phthalate or hydroxypropylmethylcellulose phthalate. Colorants or pigments can be added to the tablets or coatings of coated tablets, for example, to identify or to indicate various doses of active compound. In addition, they may also contain other therapeutically valuable substances. Said compositions are prepared according to conventional mixing, granulating or coating methods, respectively, and contain about 0.1 to 75 %, preferably about 1 to 50 %, of the active ingredient.

Suitable formulations for topical application, e.g. to the skin and eyes, are preferably aqueous solutions, ointments, creams or gels well-known in the art.

Suitable formulations for transdermal application include an effective amount of a compound of the invention with carrier. Advantageous carriers include absorbable pharmacologically acceptable solvents to assist passage through the skin of the host.

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Characteristically, transdermal devices are in the form of a bandage comprising a backing member, a reservoir containing the compound optionally with carriers, optionally a rate controlling barrier to deliver the compound of the skin of the host at a controlled and predetermined rate over a prolonged period of time, and means to secure the device to the skin.

In conjunction with another active ingredient, a compound of the invention may be administered either simultaneously, before or after the other active ingredient, either separately by the same or different route of administration or together in the same pharmaceutical formulation.

The invention further particularly relates to a method for the treatment of a condition or syndrome responsive to the selective antagonism of LTB₄ receptors, such as rheumatoid arthritis, inflammatory bowel disease, psoriasis, non-steroidal-antiinflammatory-drug-induced gastropathy, adult respiratory distress syndrome (ARDS), myocardial infarction, allergic rhinitis, hemodialysis-induced neutropenia, and late phase asthma; also for the treatment of osteoarthritis, of pain and of ocular allergies and inflammations; and also for the treatment of atopic and contact dermatitis.

The dosage of active compound administered is dependent on the species of warm-blooded animal (mammal), the body weight, age and individual condition, and on the form of administration. A unit dosage for oral administration to a mammal of about 70 kg may contain e.g. between about 1 and about 1000 mg/kg per day of the active ingredient.

The following examples are intended to illustrate the invention and are not to be construed as being limitations thereon. Temperatures are given in degrees Centigrade. If not mentioned otherwise, all evaporation are performed under reduced pressure, preferably between about 15 and 100 mm Hg. The structure of final products, intermediates and starting materials is confirmed by standard analytical methods, e.g. microanalysis and spectroscopic characteristics (e.g. MS, IR, NMR). Abbreviations used are those conventional in the art.

The compounds wherein R₃ is not hydrogen have been assigned the isomeric structure in which R₃ is located on the imino (C=N) nitrogen of the amidine group; however, such may also exist in the isomeric form in which R₃ is on the amino nitrogen of the amidine

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group.

Example 1

A stirred, 0°C solution of ethyl 5-[5-(4-cyanophenoxy)pentyloxy]-2-[N-(1-methyl-ethyl)-N-phenylaminocarbonyl]phenoxyacetate (200 mg, 0.44 mmol) in 2.0 mL of anhydrous dichloromethane and 150 mL of anhydrous ethanol at 0°C is treated with anhydrous hydrogen chloride gas over 30 minutes. This solution is stirred at room temperature for 20 hours and the resulting solution is concentrated in vacuo. The resulting ethyl 4-[5-[3-ethoxycarbonylmethoxy-4-[N-(1-methylethyl)-N-phenyl-aminocarbonyl]-phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride is then dissolved in 50 mL of anhydrous ethanol in a pressure tube, and treated with anhydrous ammonia for 5 minutes at 0°C. The pressure tube is sealed and heated to 100°C for 1 hour. Upon cooling and concentrating in vacuo, the resulting material is purified by chromatography on silica gel (15 g) with 5-20% methanol/dichloromethane as the eluent to afford 4-[5-[4-(amino-iminomethyl)phenoxy]pentyloxy]-2-carbamoylmethoxy-N-(1-methylethyl)-N-phenylbenzamide monohydrochloride as colorless foam; CHN calculated for C₃₀H₃₇ClN₄O₅-0.5 H₂O:

Theory: %C: 62.33; % H: 6.63; % N: 9.69;

Found: %C: 62.05; % H: 6.68; % N: 9.54.

IR(cm⁻¹): 1673, 1653, 1609; MS 527 (M+1).

The starting material, ethyl 5-[5-(4-cyanophenoxy)pentyloxy]-2-[N-(1-methylethyl)-N-phenylaminocarbonyl]phenoxyacetate, can be prepared, for example, as follows:

A stirred solution of 2,4-dimethoxybenzoic acid (4.31 g, 23.7 mmol) in 35 mL of dichloromethane is treated with N-isopropylaniline (3.07 mL, 21.33 mmol), hydroxybenzotriazole (3.2 g, 23.7 mmol), and 1-ethyl-3-[3-(dimethylamino)propyl]-carbodiimide hydrochloride (4.54 g, 23.7 mmol). This solution is stirred at room temperature for 18 hours and the resulting solution is partitioned between ethyl acetate and 1N hydrochloride solution. The organic layer is washed with water, dried over sodium sulfate and concentrated. The resulting material is purified by chromatography on silica gel (150 g) with 40-60 % ethyl acetate/hexane as the eluent to afford 2,4-dimethoxy-N-(1-methylethyl)-N-phenylbenzamide as a colorless foam.

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A stirred solution of 2,4-dimethoxy-N-(1-methylethyl)-N-phenylbenzamide (2.4 g, 8.03 mmol) in 10 ml of dichloromethane at 0°C was treated with 1N boron tribromide (33.2 mL, 33.2 mmol) and stirred at room temperature for 1 hour. The reaction is poured in to the ice water. After stirring for 15 minutes, the reaction was partitioned between ethyl acetate and brine, dried over magnesium sulfate and concentrated in vacuo to afford yellow foam. This material is purified by chromatography on silica gel (70 g) with 3-5 % methanol/dichloromethane as the eluent to afford 2,4-dihydroxy-N-(1-methylethyl)-N-phenylbenzamide as colorless foam.

A stirred solution of 2,4-dihydroxy-N-(1-methylethyl)-N-phenylbenzamide (358 mg, 1.32 mmol) in 6 mL of N,N-dimethylformamide is treated with cesium carbonate (520 mg, 1.58 mmol), and 5-(4-cyanophenoxy)pentyl bromide (U.S. Patent 4,451,476, 354 mg, 1.32 mmol) and stirred at 40°C for 24 hours. The reaction is partitioned between ethyl acetate and water, dried over sodium sulfate and concentrated in vacuo to afford a yellow foam. This material is purified by chromatography on silica gel (30 g) with 30-70 % ethyl acetate/hexane as the eluent to afford 4-[5-(4-cyanophenoxy)pentyloxy]-2-hydroxy-N-(1-methylethyl)-N-phenylbenzamide as colorless foam.

A stirred solution of 4-[5-(4-cyanophenoxy)pentyloxy]-2-hydroxy-N-(1-methylethyl)-N-phenylbenzamide (250 mg, 0.55 mmol) in 2.5 mL of N,N-dimethylformamide is treated with 60 % sodium hydride (22 mg, 0.55 mmol), and ethyl bromoacetate (67 µL, 0.60 mmol) and heated at 70°C for 2.5 hours. The reaction is partitioned between ethyl acetate and water, dried over sodium sulfate and concentrated in vacuo to afford a yellow foam. This material is purified by chromatography on silica gel (30 g) with 50-70 % ethyl acetate/hexane as the eluent to afford ethyl 5-[5-(4-cyanophenoxy)pentyloxy]-2-[N-(1-methylethyl)-N-phenylaminocarbonyl]phenoxyacetate as colorless foam.

Example 2

A stirred, 0°C solution of ethyl 4-[5-[3-ethoxycarbonylmethoxy-4-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride (400 mg, 0.68 mmol) in 25 mL of anhydrous ethanol is treated with 1.36 mL of 1.0 N aqueous sodium hydroxide. After stirring 1.5 hours, the reaction is concentrated in vacuo. The resulting 5-[5-[4-(ethoxyiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxyacetic acid is then dissolved in 50 mL of

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anhydrous ethanol in a pressure tube, and treated with ammonium chloride (500 mg, 9.4 mmol). This mixture is treated with anhydrous ammonia for 2 minutes at 0°C. The pressure tube is sealed and heated to 50°C for 1 hour. Upon cooling and concentrating in vacuo, the resulting material is purified by chromatography on silica gel (15 g) with 20-30% methanol/dichloromethane as the eluent to afford a colorless foam. The resulting 5-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)- carbamoyl]phenoxyacetic acid monohydrochloride is then dissolved in 150 mL of anhydrous ethanol at 0°C and treated with anhydrous hydrogen chloride gas over 30 minutes. This solution is stirred at room temperature for 20 hours and the resulting solution is concentrated in vacuo. The resulting material is purified by chromatography on silica gel (15 g) with 5-20% methanol/dichloromethane as the eluent to afford ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]- phenoxyacetate monohydrochloride as colorless foam; CHN calculated for C₂₉H₄₂ClN₃O₆·1.0 H₂O:

Theory: %C: 59.83; % H: 7.62; % N: 7.22;

Found: %C: 59.92; % H: 7.22; % N: 7.37.

IR(cm⁻¹): 1758, 1667, 1609.

The starting material, ethyl 4-[5-[3-ethoxycarbonylmethoxy-4-[N,N-bis(1-methyl- ethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride, can be prepared, for example, as follows:

A stirred solution of 2,4-dimethoxybenzoyl chloride (10.0 g, 50 mmol) in 10 mL of dichloromethane at 0°C is treated with 30 mL of diisopropylamine. This solution is stirred at room temperature for 1 hour and the resulting solution is partitioned between ethyl acetate and water. The organic layer is washed with 1N hydrochloride solution, 1N sodium hydroxide solution, water and brine, dried over sodium sulfate and concentrated in vacuo to give 2,4-dimethoxy-N,N-bis(1-methylethyl)benzamide.

A solution of 2,4-dimethoxy-N,N-bis(1-methylethyl)benzamide (3.0 g, 11.0 mmol) in 10 ml of dichloromethane at 0°C is treated with 1N boron tribromide (33.0 mL, 33.0 mmol) and stirred at room temperature for 2 hours. The reaction is concentrated in vacuo, dissolved in 1N sodium hydroxide solution, and acidified with 1N hydrochloric acid to generate solid which is filtered to afford 2,4-dihydroxy-N,N-bis(1-methylethyl)benzamide as white solid.

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A solution of 2,4-dihydroxy-N,N-bis(1-methylethyl)benzamide (3 g, 12.7 mmol) in 30 mL of N,N-dimethylformamide is treated with cesium carbonate (4.97 g, 15.2 mmol), and 5-(4-cyanophenoxy)pentyl bromide (3.4 g, 12.7 mmol) and stirred at 40°C for 24 hours. The reaction is partitioned between ethyl acetate and water, dried over sodium sulfate and concentrated in vacuo to afford a yellow foam. This material is purified by chromatography on silica gel (30 g) with 30-70 % ethyl acetate/hexane as the eluent to afford 4-[5-(4-cyanophenoxy)pentyloxy]-2-hydroxy-N,N-bis(1-methylethyl)benzamide as colorless foam.

A stirred solution of 4-[5-(4-cyanophenoxy)pentyloxy]-2-hydroxy-N,N-bis(1-methylethyl)benzamide (0.5 g, 1.18 mmol) in 10.0 mL of N,N-dimethylformamide is treated with 60 % sodium hydride (47 mg, 1.18 mmol) and ethyl bromoacetate (144 µL, 1.3 mmol), and heated at 70°C for 2.5 hours. The reaction is partitioned between ethyl acetate and water, dried over sodium sulfate and concentrated in vacuo to afford yellow foam. The resulting ethyl 5-[5-(4-cyanophenoxy)pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxyacetate in 50 mL of anhydrous ethanol at 0°C is treated with anhydrous hydrogen chloride gas over 30 minutes. This solution is stirred at room temperature for 20 hours and concentrated in vacuo. This material is purified by chromatography on silica gel with 60 % ethyl acetate/hexane as the eluent to afford ethyl 4-[5-[3-ethoxycarbonylmethoxy-4-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride as colorless foam.

Example 3

A stirred, refluxing mixture of 4-[5-(4-cyanophenoxy)pentyloxy]-2-hydroxy-N,N-bis(1-methylethyl)benzamide (0.5 g, 1.18 mmol), sodium hydroxide (480 mg, 1.2 mmol), and 50 mL of acetone is treated with chloroform (125 uL, 1.6 mmol) in 20 mL of acetone. The reaction is refluxed for 4 hours and concentrated in vacuo. The resulting material is partitioned between ethyl acetate and 1N hydrochloric acid. The organic layer is washed with brine, dried over magnesium sulfate and concentrated. The resulting material is purified by chromatography on silica gel (20 g) with 40-100% ethyl acetate/hexane followed by 10% MeOH/ethyl acetate as the eluent to afford 5-[5-[4-cyanophenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetic acid as colorless foam. A stirred, 0°C solution of 5-[5-[4-cyanophenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]-

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phenoxydimethylacetic acid (210 mg, 0.411 mmol) in 2.0 mL of anhydrous dichloromethane and 150 mL of anhydrous ethanol at 0°C is treated with anhydrous hydrogen chloride gas over 30 minutes. This solution is stirred at room temperature for 20 hours and the resulting solution is concentrated in vacuo. The resulting ethyl 4-[5-[3-ethoxycarbonyldimethylmethoxy-4-[N,N-bis(1-methyl-ethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride is then dissolved in 50 mL of anhydrous ethanol in a pressure tube, and treated with anhydrous ammonia for 5 minutes at 0°C. The pressure tube is sealed and heated to 100°C for 1 hour. Upon cooling and concentrating in vacuo, the resulting material is purified by chromatography on silica gel (15 g) with 5-20% methanol/dichloromethane as the eluent to afford ethyl 5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate monohydrochloride as colorless foam; CHN calculated for C₃₁H₄₆ClN₃O₆-1.25 H₂O:
Theory: %C: 60.57; % H: 7.95; % N: 6.84;
Found: %C: 60.57; % H: 7.92; % N: 6.92.
MS: 612 (M+1).

Example 4

In a way analogously as described in the previous examples, the following compounds can be prepared:

(a) 4-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-(dimethylcarbamoylmethoxy)-N,N-bis(1-methylethyl)benzamide monohydrochloride is obtained from ethyl 4-[5-[3-(dimethylcarbamoylmethoxy)-4-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride as colorless foam;

CHN calculated for C₂₉H₄₃ClN₄O₅-2.5 H₂O:

Theory: %C: 57.27; % H: 7.96; % N: 9.21;

Found: %C: 57.65; % H: 7.73; % N: 8.88.

IR(cm⁻¹): 1673, 1653, 1609.

The starting alkylating material is α-bromo-N,N-dimethylacetamide.

(b) 4-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-(diethylcarbamoylmethoxy)-N,N-bis(1-methylethyl)benzamide monohydrochloride is obtained

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from ethyl 4-[5-[3-(diethylcarbamoylmethoxy)-4-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride as colorless foam; CHN calculated for $C_{31}H_{47}ClN_4O_5 \cdot 0.5 H_2O$:

Theory: %C: 62.04; % H: 8.06; % N: 9.33;

Found: %C: 61.90; % H: 8.07; % N: 9.25.

IR(cm^{-1}): 1667, 1644, 1610.

The starting alkylating material is α -bromo-N,N-diethylacetamide.

(c) 4-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-N,N-bis(1-methylethyl)-2-[bis(1-methylethyl)carbamoylmethoxy]benzamide monohydrochloride is obtained from ethyl 4-[5-[3-[bis(1-methylethyl)carbamoylmethoxy]-4-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride as colorless foam; CHN calculated for $C_{33}H_{51}ClN_4O_5 \cdot 1.0 H_2O$:

Theory: %C: 62.20; % H: 8.38; % N: 8.79;

Found: %C: 62.36; % H: 8.05; % N: 8.72.

IR(cm^{-1}): 1666, 1640, 1609.

The starting alkylating material is α -bromo-N,N-diisopropylacetamide.

(d) Ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[bis(1-methylethyl)carbamoyl]phenoxy]pentanoate monohydrochloride is obtained from ethyl 4-[5-[3-ethoxycarbonylbutoxy]-4-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride as colorless foam; CHN calculated for $C_{32}H_{48}ClN_3O_6$:

Theory: %C: 63.40; % H: 7.78; % N: 6.93;

Found: %C: 63.02; % H: 7.87; % N: 7.15.

IR(cm^{-1}): 1728, 1674, 1609.

The starting alkylating material is ethyl 5-bromopentanoate.

(e) 4-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-carbamoylmethoxy-N,N-bis(1-methylethyl)benzamide monohydrochloride is obtained from ethyl 4-[5-[3-ethoxycarbonylmethoxy]-4-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy]pentyloxy]benzenecarboximidoate monohydrochloride as colorless foam; CHN calculated for $C_{27}H_{39}ClN_4O_5 \cdot 1.5 H_2O$:

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Theory: %C: 57.69; % H: 7.53; % N: 9.97;

Found: %C: 57.64; % H: 7.34; % N: 9.88.

IR(cm⁻¹): 1676, 1608.

The starting alkylating material is ethyl α -bromoacetate.

Example 5

To a mixture of 0.47 g (1.0 mmol) of 4-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-carbamoylmethoxy-N,N-bis(1-methylethyl)benzamide in 10 ml of methylene chloride is added 0.14 g (1.0 mmol) of phenyl acetate. The mixture is stirred at room temperature for 4 hours and then poured onto a silica gel column and eluted with ethyl acetate, and then 10% methanol/ethyl acetate to give 4-[5-[4[(acetylimino)aminomethyl]phenoxy]-pentyloxy]-2-carbamoylmethoxy-N,N-bis(1-methylethyl)benzamide as a foam; CHN calculated for C₂₉H₄₀N₄O₈·0.5H₂O:

Theory: %C: 63.37; %H: 7.52; %N: 10.19;

Found: %C: 63.41; %H: 7.53; %N: 9.85;

NMR (CDCl₃): 7.80 (d, 2H), 6.95 (d, 1H), 6.85 (d, 2H), 6.45 (dd, 1H), 6.40 (d, 1H), 4.45 (d, 2H), 3.95 (t, 2H), 3.90 (t, 2H), 3.80 (br, 1H), 3.45 (br, 1H), 2.20 (s, 3H), 1.80 (m, 4H), 1.60 (m, 2H), 1.45 (br, 6H), 1.05 (br, 6H).

Example 6

To a mixture of 0.85 g (1.4 mmol) of ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]-pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate monohydrochloride in 10 ml of methylene chloride is added 0.39 g (2.8 mmol) of phenyl acetate and 1 ml of triethylamine. The mixture is stirred at room temperature for 2 days and then poured onto a silica gel column and eluted with 80% ethyl acetate/hexane, and then pure ethyl acetate to give ethyl 5-[5-[4[(acetylimino)aminomethyl]phenoxy]-pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate as a foam; CHN calculated for C₃₃H₄₇N₃O₇·0.5H₂O:

Theory: %C: 65.32; %H: 7.97; %N: 6.93;

Found: %C: 65.23; %H: 7.67; %N: 6.84;

NMR (CDCl₃): 7.80 (d, 1H), 6.80 (d, 2H), 6.70 (d, 2H), 6.35 (dd, 1H), 6.20 (d, 1H), 4.10

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(q, 2H), 3.90 (t, 2H), 3.80 (t, 2H), 3.70 (septet, 1H), 3.45 (septet, 1H), 2.10 (s, 3H), 1.70 (m, 4H), 1.50 (m, 2H), 1.45 (s, 3H), 1.40 (s, 3H), 1.40 (d, 6H), 1.10 (d, 3H), 1.10 (t, 3H), 0.9 (d, 3H).

Example 7

To a mixture of 0.2 g (0.34 mmol) of ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]-pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate monohydrochloride in 10 ml of methylene chloride is added 0.11 g (0.67 mmol) of isonicotinoyl chloride hydrochloride and 0.5 ml of triethylamine. The mixture is stirred at room temperature for 2 days and then poured onto a silica gel column and eluted with 80% ethyl acetate/hexane to afford ethyl 5-[5-[4-(isonicotinoylimino)aminomethyl]phenoxy]-pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate as a foam; CHN calculated for $C_{37}H_{48}N_4O_7 \cdot 0.5H_2O$:

Theory: %C: 66.35; %H: 7.37; %N: 8.36;

Found: %C: 66.71; %H: 7.15; %N: 8.21;

NMR ($CDCl_3$): 10.60 (br, 1H), 8.60 (br, 2H), 8.50 (br, 1H), 8.05 (br, 2H), 8.00 (d, 2H), 6.90 (d, 1H), 6.80 (d, 2H), 6.40 (dd, 1H), 6.20 (d, 1H), 4.10 (q, 2H), 3.90 (t, 2H), 3.80 (t, 2H), 3.70 (septet, 1H), 3.40 (septet, 1H), 1.70 (m, 4H), 1.60 (m, 2H), 1.50 (s, 3H), 1.45 (d, 6H), 1.40 (s, 3H), 1.10 (t, 3H), 1.10 (d, 3H), 0.90 (d, 3H).

Example 8

A mixture of 0.16 g (0.26 mmol) of ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]-pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate monohydrochloride and 10 ml of 6N hydrochloric acid is heated to reflux for 16 hours. The mixture is cooled to room temperature and then concentrated under reduced pressure at 50°C to afford 5-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methyl-ethyl)carbamoyl]phenoxydimethylacetic acid as an oil; CHN calculated for $C_{29}H_{41}N_3O_6 \cdot HCl \cdot 0.5H_2O$:

Theory: %C: 60.77; %H: 7.56; %N: 7.33;

Found: %C: 60.47; %H: 7.56; %N: 7.25;

NMR (CH_3OD): 9.10 (br, 1H), 8.55 (br, 1H), 7.80 (d, 2H), 7.10 (d, 2H), 7.00 (d, 1H), 6.60 (dd, 1H), 6.40 (d, 1H), 4.15 (t, 2H), 4.00 (t, 2H), 3.80 (septet, 1H), 3.60 (septet, 1H), 1.90

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(m, 4H), 1.70 (m, 2H), 1.60 (s, 3H), 1.55 (s, 3H), 1.50 (d, 6H), 1.25 (d, 3H), 1.05 (d, 3H).

Example 9

Similarly to procedures described in the previous examples, the following compounds can be prepared:

(a) Ethyl 5-[5-[4-[amino(propanoylimino)methyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate as a colorless foam; CHN calculated for $C_{34}H_{49}N_3O_7$:

Theory: %C: 65.78; % H: 8.12; % N: 6.77;

Found: %C: 65.87; % H: 7.99; % N: 6.62;

IR(cm^{-1}): 1732, 1607.

(b) Ethyl 5-[5-[4-[amino(propanoylimino)methyl]phenoxy]-pentyloxy]-2-[N-phenyl-N-(1-methylethyl)aminocarbonyl]phenoxydimethylacetate as an oil; CHN calculated for $C_{37}H_{47}N_3O_7$:

Theory: %C: 68.81; %H: 7.34; %N: 6.51;

Found: %C: 68.55; %H: 7.10; %N: 6.24;

IR(cm^{-1}): 1730, 1608.

(c) Ethyl 5-[5-[4-(iminoaminomethyl)-phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy-4-butanoate monohydrochloride as a colorless solid; CHN calculated for $C_{31}H_{46}ClN_3O_6 \cdot 0.5H_2O$:

Theory: %C: 61.93; %H: 7.88; %N: 6.99;

Found: %C: 61.99; %H: 8.04; %N: 7.02;

IR(cm^{-1}): 1729; MS: 556(M+1).

(d) Ethyl 5-[5-[4-[(acetylimino)aminomethyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy-4-butanoate, as an oil; CHN calculated for $C_{33}H_{47}N_3O_7$:

Theory: %C: 66.31; %H: 7.93; %N: 7.03;

Found: %C: 65.97; %H: 7.67; %N: 6.89;

IR(cm^{-1}): 1727, 1608; MS: 599(M+1).

(e) 5-[5-[4-(Iminoaminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)-

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aminocarbonyl]phenoxy-4-butanoic acid monohydrochloride, as a colorless solid; CHN calculated for C₂₉H₄₂ClN₃O₆H₂O:

Theory: %C: 59.82; %H: 7.62; %N: 7.22;

Found: %C: 60.06; %H: 7.66; %N: 6.64.

(f) Ethyl 5-[5-[4-[(3-pyridylcarbonylimino)aminomethyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy-4-butanoate, as an oil; CHN calculated for C₃₇H₄₈N₄O₇:

Theory: %C: 67.26; %H: 7.32; %N: 8.48;

Found: %C: 66.93; %H: 7.40; %N: 8.37;

IR(cm⁻¹): 1727, 1606.

(g) Ethyl 5-[5-[4-[(3-pyridylcarbonylimino)aminomethyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxydimethylacetate as a colorless foam; CHN calculated for C₃₇H₄₈N₄O₇:

Theory: %C: 67.26; %H: 7.32; %N: 8.48;

Found: %C: 66.93; %H: 7.23; %N: 8.31;

IR(cm⁻¹): 1728, 1608; MS: 528(M+1).

Example 10

a) Preparation of 10,000 tablets each containing 20 mg of the active ingredient, for example, the compound of example 6:

active ingredient	200.00 g
Lactose	2,535.00 g
Corn starch	125.00 g
Polyethylene glycol 6,000	150.00 g
Magnesium stearate	40.00 g
Purified water	q.s.

Procedure: All the powders are passed through a screen with openings of 0.6 mm. The drug substance, lactose, magnesium stearate and half of the starch are mixed in a suitable mixer. The other half of the starch is suspended in 65 ml of water and the suspension added to the boiling solution of the polyethylene glycol in 250 ml of water. The paste formed is added to the powders, which are granulated, if necessary, with an additional

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amount of water. The granulate is dried overnight at 35°C broken on a screen with 1.2 mm openings and compressed into tablets, using concave punches uppers bisected.

Analogously tablets are prepared, containing about 10-100 mg of one of the other compounds disclosed and exemplified herein.

b) Preparation of 1,000 capsules each containing 40 mg of the active ingredient, for example, the compound of example 6:

active ingredient	40.00 g
Lactose	177.00 g
Modified starch	80.00 g
Magnesium stearate	3.00 g

Procedure: All the powders are passed through a screen with openings of 0.6 mm. The drug substance is placed in a suitable mixer and mixed first with the magnesium stearate, then with the lactose and starch until homogenous. No. 2 hard gelatin capsules are filled with 300 mg of said mixture each, using a capsule filling machine.

Analogously capsules are prepared, containing about 10-100 mg of the other compounds disclosed and exemplified herein.

(c) Preparation of 3000 capsules each containing 25 mg of the active ingredient, for example, the compound of example 6:

Active ingredient	75.00 g
Lactose	750.00 g
Avicel PH 102 (microcrystalline cellulose)	300.00 g
Polyplasdone XL (polyvinylpyrrolidone)	30.00 g
Purified water	q.s.
Magnesium stearate	9.0 g

The active ingredient is passed through a No. 30 hand screen.

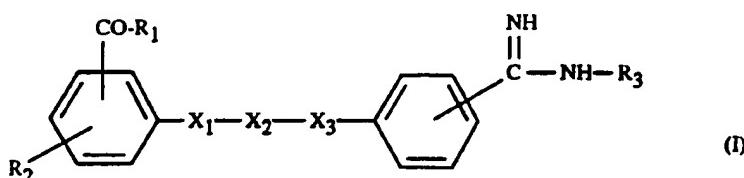
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The active ingredient, lactose, Avicel PH 102 and Polyplasdone XL are blended for 15 minutes in a mixer. The blend is granulated with sufficient water (about 500 mL), dried in an oven at 35°C overnight, and passed through a No. 20 screen.

Magnesium stearate is passed through a No. 20 screen, added to the granulation mixture, and the mixture is blended for 5 minutes in a mixer. The blend is encapsulated in No. 0 hard gelatin capsules each containing an amount of the blend equivalent to 25 mg of the active ingredient.

WHAT IS CLAIMED IS:

1. A compound of the formula



wherein the C(=NH)-NHR₃ group may be in tautomeric or isomeric form,
R₁ is amino which is mono- or disubstituted by a substituent selected from an aliphatic hydrocarbon radical, an araliphatic hydrocarbon radical, an aromatic radical, and a cycloaliphatic hydrocarbon radical, or is amino which is disubstituted by a divalent aliphatic hydrocarbon radical or a said radical interrupted by oxygen;
R₂ is hydroxy which is etherified by an aliphatic alcohol which is substituted by carboxy, by esterified carboxy or by amidated carboxy;
R₃ is hydrogen or an acyl radical which is derived from an organic carbonic acid, an organic carboxylic acid, a sulfonic acid, or a carbamic acid;
X₁ and X₃, independently of one another, are oxygen (-O-) or sulphur (-S-); and
X₂ is a divalent aliphatic hydrocarbon radical which may be interrupted by an aromatic radical;
wherein the phenyl rings of formula I may be, independently of one another, further substituted by one or more substituents selected from halogen, trifluoromethyl, an aliphatic hydrocarbon radical, hydroxy, and hydroxy which is etherified by an aliphatic alcohol or which is esterified by an aliphatic or araliphatic carboxylic acid;
wherein aryl in the above definitions may be, independently of one another, further substituted by one or more substituents selected from halogen, trifluoromethyl, an aliphatic hydrocarbon radical, hydroxy, and hydroxy which is etherified by an aliphatic alcohol or which is esterified by an aliphatic or araliphatic carboxylic acid;
wherein a cycloaliphatic hydrocarbon radical may be substituted by an aliphatic radical; or a pharmaceutically acceptable salt thereof.

2. A compound according to claim 1 wherein

R₁ is amino which is mono- or disubstituted by a substituent selected from lower alkyl, lower alkenyl, lower alkynyl, phenyl-lower alkyl, phenyl-lower alkenyl, phenyl-lower alkynyl, phenyl, naphthyl, indanyl, fluorenlyl, cycloalkyl, and cycloalkenyl, cycloalkyl and cycloalkenyl each being unsubstituted or mono- or polysubstituted by lower alkyl, or is amino which is disubstituted by lower alkylene;

R₂ is lower alkoxy substituted by carboxy, lower alkoxy carbonyl, aminocarbonyl or mono- or di-lower alkylaminocarbonyl;

R₃ is hydrogen, alkoxy carbonyl or alkenyloxycarbonyl, each of which is unsubstituted or substituted by phenyl, naphthyl, indanyl or fluorenlyl, or is cycloalkoxycarbonyl being unsubstituted or mono- or polysubstituted by lower alkyl, or is lower alkanoyl or phenyl-lower alkanoyl, or is benzoyl, naphthoyl, indanoyl or fluorenoyl, or is C₁-C₇alkanesulfonyl, phenyl-C₁-C₇alkanesulfonyl, C₃-C₇cycloalkanesulfonyl, or phenylsulfonyl, or is aminocarbonyl which is substituted by lower alkyl, phenyl-lower alkyl or phenyl;

X₁ and X₃, independently of one another, are O or S;

X₂ is lower alkylene, lower alkylene-phenylene-lower alkylene or lower alkylene-naphthylene-lower alkylene;

wherein the phenyl rings of formula I may be, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, lower alkyl, lower alkenyl, lower alkynyl, hydroxy, lower alkoxy, lower alkenyloxy, phenyl-lower alkoxy, lower alkanoyloxy, lower alkenoyloxy and phenyl-lower alkanoyloxy;

wherein the aromatic radicals in the above definitions may be, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, lower alkyl, lower alkenyl, lower alkynyl, hydroxy, lower alkoxy, lower alkenyloxy, phenyl-lower alkoxy, lower alkanoyloxy, lower alkenoyloxy and phenyl-lower alkanoyloxy; or a pharmaceutically acceptable salt thereof.

3. A compound according to claim 1 wherein

R₁ is amino which is mono- or disubstituted by a substituent selected from C₁-C₇alkyl, phenyl-C₁-C₇alkyl, phenyl and C₃-C₆cycloalkyl, C₃-C₆cycloalkyl being unsubstituted or mono- or polysubstituted by C₁-C₇alkyl, or is amino which is disubstituted by C₃-C₆alkylene;

R₂ is C₁-C₇alkoxy substituted by carboxy or lower alkoxy carbonyl;

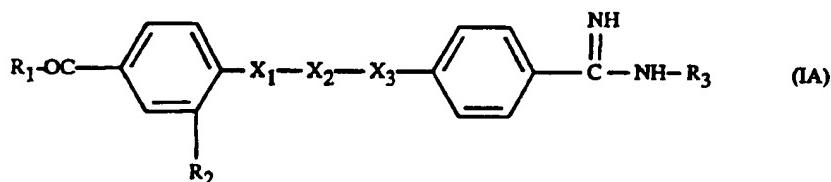
R₃ is hydrogen, C₁-C₁₂alkoxy-carbonyl, C₂-C₅alkanoyl, phenyl-C₂-C₅alkanoyl, benzoyl which is unsubstituted or substituted by halogen, trifluoromethyl, C₁-C₇alkyl, or C₁-C₇alkoxy, C₃-C₆cycloalkylcarbonyl which is unsubstituted or substituted by

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C_1 - C_7 -alkyl, or is benzoyl, naphthoyl, indanoyl or fluorenoyl, or is C_1 - C_7 alkanesulfonyl, phenyl- C_1 - C_7 alkanesulfonyl, C_3 - C_7 -cycloalkanesulfonyl, or phenylsulfonyl, or is aminocarbonyl which is substituted by C_1 - C_7 -alkyl, phenyl- C_1 - C_7 -alkyl or phenyl; X_1 and X_3 each are -O-; X_2 is C_2 - C_7 -alkylene or C_2 - C_4 -alkylene-phenylene- C_2 - C_4 -alkylene; wherein the phenyl rings of formula I may be unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C_1 - C_7 -alkyl, and C_1 - C_7 -alkoxy; wherein phenyl in the above definitions is unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C_1 - C_7 -alkyl, and C_1 - C_7 -alkoxy; or a pharmaceutically acceptable salt thereof.

4. A compound according to claim 1 wherein -CO-R₁ is located in position 4 (para) of the corresponding phenyl ring with respect to -X₁-; R₂ is located in position 2 (ortho) or 3 (meta) of the corresponding phenyl ring with respect to -X₁-; and -C(=NH)-NHR₃ is located in position 4 (para) of the corresponding phenyl ring with respect to -X₃-.

5. A compound according to claim 1 of the formula IA



wherein the C(=NH)-NHR₃ group may be in tautomeric or isomeric form, R₁ is di- C_1 - C_4 -alkylamino, C_1 - C_4 alkyl-(phenyl)amino, C_1 - C_4 alkyl-(phenyl- C_1 - C_4 -alkyl)-amino, di- C_3 - C_6 -cycloalkylamino which is unsubstituted or substituted by C_1 - C_4 -alkyl, or 1-piperidino substituted by C_1 - C_4 -alkyl; R₂ is C_1 - C_4 -alkoxy which is substituted by carboxy, lower alkoxy carbonyl, aminocarbonyl or by mono- or di-lower alkylaminocarbonyl; R₃ is hydrogen, C_1 - C_{12} -alkoxycarbonyl, phenyl- C_1 - C_4 -alkoxycarbonyl, C_2 - C_5 -alkanoyl, benzoyl which is unsubstituted or substituted by halogen, trifluoromethyl, C_1 - C_4 -alkyl or by C_1 - C_4 -alkoxy, or C_3 - C_6 -cycloalkylcarbonyl which is unsubstituted or substituted by C_1 - C_4 -alkyl;

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X_1 and X_3 are -O-;

X_2 is C_4 - C_7 -alkylene;

wherein the phenyl rings of formula IA may be unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C_1 - C_4 -alkyl and C_1 - C_4 -alkoxy; or a pharmaceutically acceptable salt thereof.

6. A compound according to claim 5 wherein R_2 is C_1 - C_4 -alkoxy substituted by C_1 - C_4 -alkoxycarbonyl such as ethoxycarbonyl or by aminocarbonyl and X_2 is pentylene.

7. A compound according to claim 5 wherein

R_1 is di- C_1 - C_4 -alkylamino;

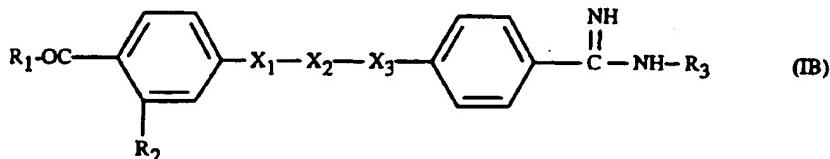
R_2 is C_1 - C_4 -alkoxy substituted by ethoxycarbonyl or aminocarbonyl R_3 is hydrogen or C_2 - C_5 -alkanoyl;

X_1 and X_3 are -O-;

X_2 is C_4 - C_7 -alkylene; or a pharmaceutically acceptable salt thereof.

8. A compound according to claim 7 wherein R_1 is di- C_1 - C_4 -alkylamino; R_2 has the meaning as given in claim 6, R_3 is hydrogen or C_2 - C_5 -alkanoyl; X_1 and X_3 are -O-; and X_2 is pentylene; or a pharmaceutically acceptable salt thereof.

9. A compound according to claim 1 of formula IB



wherein the $C(=NH)-NHR_3$ group may be in tautomeric or isomeric form,

R_1 is di- C_1 - C_4 -alkylamino, C_1 - C_4 -alkyl-(phenyl)-amino,

C_1 - C_4 -alkyl-(phenyl- C_1 - C_4 -alkyl)-amino, di- C_3 - C_6 -cycloalkylamino which is unsubstituted or substituted by C_1 - C_4 -alkyl, or 1-piperidino substituted by C_1 - C_4 -alkyl;

R_2 is C_1 - C_4 -alkoxy which is substituted by carboxy, lower alkoxycarbonyl, aminocarbonyl or by mono- or di-lower alkylaminocarbonyl;

R_3 is hydrogen, C_1 - C_{12} -alkoxycarbonyl, phenyl- C_1 - C_4 -alkoxycarbonyl, C_2 - C_5 -alkanoyl,

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benzoyl which is unsubstituted or substituted by halogen, trifluoromethyl, C₁-C₄-alkyl or by C₁-C₄-alkoxy, or C₃-C₆-cycloalkylcarbonyl which is unsubstituted or substituted by C₁-C₄-alkyl;

X₁ and X₃ are -O-;

X₂ is C₄-C₇-alkylene;

wherein the phenyl rings of formula IB may be unsubstituted or, furthermore, independently of one another, substituted by one or more substituents selected from halogen, trifluoromethyl, C₁-C₄-alkyl, and C₁-C₄-alkoxy; or a pharmaceutically acceptable salt thereof.

10. A compound according to claim 9 wherein

R₁ is di-C₁-C₄-alkylamino, C₁-C₄-alkyl-phenyl-amino,

C₁-C₄-alkyl-phenyl-C₁-C₄-alkyl-amino, di-C₃-C₆-cycloalkylamino which is unsubstituted or substituted by C₁-C₄-alkyl, or 1-piperidino substituted by C₁-C₄-alkyl;

R₂ is C₁-C₄-alkoxy substituted by C₁-C₄-alkoxycarbonyl, or by aminocarbonyl;

R₃ is hydrogen or C₂-C₅-alkanoyl;

X₁ and X₃ are -O-;

X₂ is C₄-C₇-alkylene; or a pharmaceutically acceptable salt thereof.

11. A compound according to claim 9 wherein

R₁ is di-C₁-C₄-alkylamino;

R₂ C₁-C₄-alkoxycarbonylmethoxy or aminocarbonylmethoxy;

R₃ is hydrogen or C₂-C₅-alkanoyl;

X₁ and X₃ are -O-; and

X₂ is C₄-C₇-alkylene; or a pharmaceutically acceptable salt thereof.

12. A compound according to claim 9 wherein R₂ is C₁-C₄-alkoxycarbonylmethoxy or carbamoylmethoxy, and X₂ is pentylene.

13. Ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)-carbamoyl]phenoxyacetate or a pharmaceutically acceptable salt thereof according to claim 1.

14. 5-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)-carbamoyl]phenoxyacetate or a pharmaceutically acceptable salt thereof according to claim 1.

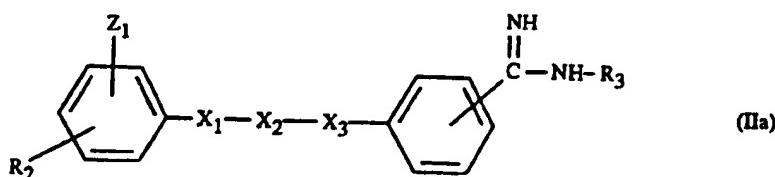
15. Ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)-carbamoyl]phenoxydimethylacetate or a pharmaceutically acceptable salt thereof according to claim 1.
16. 4-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-(dimethylcarbamoylmethoxy)-N,N-bis(1-methylethyl)benzamide or a pharmaceutically acceptable salt thereof according to claim 1.
17. 4-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-(diethylcarbamoylmethoxy)-N,N-bis(1-methylethyl)benzamide or a pharmaceutically acceptable salt thereof according to claim 1.
18. 4-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-N,N-bis(1-methylethyl)-2-[bis((1-methylethyl)carbamoylmethoxy)benzamide or a pharmaceutically acceptable salt thereof according to claim 1.
19. Ethyl 5-[5-[4-(aminoiminomethyl)phenoxy]pentyloxy]-2-[bis(1-methylethyl)carbamoyl]phenoxy]pentanoate or a pharmaceutically acceptable salt thereof according to claim 1.
20. 4-[5-[4-Aminoiminomethyl)phenoxy]pentyloxy]-2-carbamoylmethoxy-N,N-bis(1-methylethyl)benzamide or a pharmaceutically acceptable salt thereof according to claim 1.
21. 4-[5-[4-[(Acetylimino)aminomethyl]phenoxy]pentyloxy]-2-carbamoylmethoxy-N,N-bis(1-methylethyl)benzamide or a pharmaceutically acceptable salt thereof according to claim 1.
22. 5-[5-[4-[(Acetylimino)aminomethyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate or a pharmaceutically acceptable salt thereof according to claim 1.
23. Ethyl 5-[5-[4-[-isonicotinoylimino)aminomethyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate or a pharmaceutically acceptable salt thereof according to claim 1.

24. 5-[5-[4-(Aminoiminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)-carbamoyl]phenoxydimethylacetic acid or a pharmaceutically acceptable salt thereof according to claim 1.
25. Ethyl 5-[5-[4-[aminopropanoylimino)methyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)carbamoyl]phenoxydimethylacetate or pharmaceutically acceptable salt thereof according to claim 1.
26. Ethyl 5-[5-[4-[amino(propanoylimino)methyl]phenoxy]pentyloxy]-2-[N-phenyl-N-(1-methylethyl)aminocarbonyl]phenoxydimethylacetate or a pharmaceutically acceptable salt thereof according to claim 1.
27. Ethyl 5-[5-[4-(iminoaminomethyl)-phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)-aminocarbonyl]phenoxy-4-butanoate or a pharmaceutically acceptable salt thereof according to claim 1.
28. Ethyl 5-[5-[4-[(acetyllimino)aminomethyl]phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy-4-butanoate or a pharmaceutically acceptable salt thereof according to claim 1.
29. 5-[5-[4-(Iminoaminomethyl)phenoxy]pentyloxy]-2-[N,N-bis(1-methylethyl)-aminocarbonyl]phenoxy-4-butanoic acid or a pharmaceutically acceptable salt thereof according to claim 1.
30. Ethyl 5-[5-[4-[(3-pyridylcarbonylimino)aminomethyl]phenoxy]-pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxy-4-butanoate or a pharmaceutically acceptable salt thereof according to claim 1
31. Ethyl 5-[5-[4-[(3-pyridylcarbonylimino)aminomethyl]phenoxy]-pentyloxy]-2-[N,N-bis(1-methylethyl)aminocarbonyl]phenoxydimethylacetate or a pharmaceutically acceptable salt thereof according to claim 1.
32. A pharmaceutical composition suitable for antagonizing LTB₄ in mammals comprising an effective LTB₄ antagonizing amount of a compound of claim 1 and a pharmaceutically acceptable carrier.

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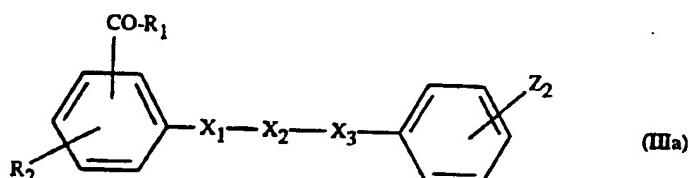
33. Process for the production of compounds of formula I defined in claim 1 and pharmaceutically acceptable salts thereof comprising

a) converting in a compound of the formula IIa



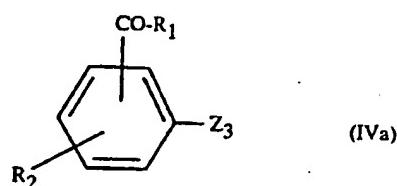
or a salt thereof in which Z_1 is a radical which can be converted into the variable $-CO-R_1$, Z_1 into the variable $-CO-R_1$, or,

b) for the manufacture of compounds of the formula I in which R_3 is hydrogen, in a compound of the formula IIIa



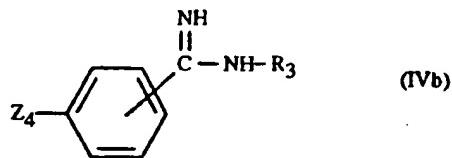
or a salt thereof in which Z_2 is a radical which can be converted into the variable $-C(=NH)-NH-R_3$, converting Z_2 into the variable $-C(=NH)-NH-R_3$, or

c) reacting a compound of the formula IVa



or a salt thereof with a compound of the formula IVb

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or a salt thereof in which Z_3 is a group of the formula $-X_1-X_2-Z_5$ and Z_4 is $-Z_6$, or Z_3 is $-Z_6$ and Z_4 is a group of the formula $Z_5-X_2-X_3-$, wherein one of the radicals Z_5 and Z_6 is hydroxy or mercapto and the other is hydroxy, mercapto or reactive esterified hydroxy, and, if desired, converting a compound of the formula I or a salt thereof obtainable according to the process or in another manner into another compound or a salt thereof according to the invention, converting a free compound of the formula I obtainable according to the process into a salt, converting a salt obtainable according to the process into the free compound of the formula I or into another salt, or resolving a mixture of isomers obtainable according to the process and isolating the desired compound.

34. A method for the treatment of a condition or syndrome responsive to the selective antagonism of LTB_4 which comprises administering to a mammal in need thereof an effective LTB_4 antagonizing amount of a compound according to claim 1 in a pharmaceutically acceptable carrier.

35. A method for the treatment of rheumatoid arthritis, inflammatory bowel disease, psoriasis, non-steroidal-antiinflammatory-drug-induced gastropathy, adult respiratory distress syndrome (ARDS), myocardial infarction, allergic rhinitis, ocular allergy and inflammation, hemodialysis-induced neutropenia, atopic or contact dermatitis, or late phase asthma in mammals, which comprises administering to a mammal in need thereof an effective amount of a compound according to claim 1 in a pharmaceutically acceptable carrier.

36. A method for the treatment of osteoarthritis and pain which comprises administering to a mammal in need thereof an effective analgesic amount of a compound according to claim 1 in a pharmaceutically acceptable carrier.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 93/10876

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: C07C 257/18, C07C 257/20, C07D 213/81, A61K 31/165, C07C 271/64,
C07C 311/51, C07C 323/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: A61K, C07C, C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

MEDLINE, BIOSIS, EMBASE, WPI, CHEMICAL ABSTRACTS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	EP, A2, 0518819 (CIBA-GEIGY AG), 16 December 1992 (16.12.92) --	1-33
P, X	EP, A2, 0518818 (CIBA-GEIGY AG), 16 December 1992 (16.12.92) --	1-33
X	EP, A2, 0150118 (MERCK FROSST CANADA INC.), 31 July 1985 (31.07.85) --	1-33
P, X	WO, A1, 9316036 (BOEHRINGER INGELHEIM KG), 19 August 1993 (19.08.93) -- -----	1-33

<input type="checkbox"/>	Further documents are listed in the continuation of Box C.	<input checked="" type="checkbox"/> See patent family annex.
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* Special categories of cited documents:	
"A"	document defining the general state of the art which is not considered to be of particular relevance
"B"	earlier document but published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reasons (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 February 1994	- 9. 03. 94
Name and mailing address of the ISA/ European Patent Office, P.O. 5818 Pionierlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Telex 31 651 epo nl. Fax (+31-70) 340-5016	Authorized officer ELISABETH CARLBORG

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 93/10876

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: 34-36
because they relate to subject matter not required to be searched by this Authority, namely:
See PCT Rule 39.1(iv): Methods for treatment of the human or animal body by surgery or therapy, as well as diagnostic methods.
2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

30/12/93

International application No.

PCT/US 93/10876

Patent document cited in search report	Publication date		Patent family member(s)		Publication date
EP-A2- 0518819	16/12/92	AU-A-	1807392	17/12/92	
EP-A2- 0518818	16/12/92	AU-A- HU-A- US-A-	1807292 61977 5246965	17/12/92 29/03/93 21/09/93	
EP-A2- 0150118	31/07/85	CA-A- JP-A- US-A-	1243322 60163852 4717736	18/10/88 26/08/85 05/01/88	
WO-A1- 9316036	19/08/93	DE-A-	4203201	12/08/93	